Exploring Biodiversity for Ecotourism: "A Flora and Fauna Assessment of the Haa-Nubtshonapata Trek"

Haa Dzongkhag

JIGME KHESAR STRICT NATURE RESERVE

Department of Forests and Park Services

Ministry of Energy and Natural Resources

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Flora & Fauna Assessment Report

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FORWARD

It gives me great pleasure to present this Field Survey Report on Flora and Fauna along the Nubtshonapata Trek, often referred to as the "Poppy Trek". This report is a testament to our ongoing efforts to promote eco-tourism and biodiversity conservation in Bhutan, particularly, within the Jigme Khesar Strict Nature Reserve, a region renowned for its exceptional natural beauty and ecological significance.

The Nubtshonapata Trek, nestled in the pristine wilderness of Haa, offers a unique opportunity for tourists and nature enthusiasts to explore one of Bhutan's most biodiverse areas. This trail not only provides a chance to encounter the elusive Snow Leopard but also showcases the rare and endemic White poppy, alongside a diverse array of flora and fauna that thrive in this high-altitude environment.

The Department of Tourism is committed to enhancing the trekking experience by promoting sustainable and responsible tourism practices that protect and celebrate our natural heritage. The findings of this survey will play a crucial role in achieving this goal by documenting the rich biodiversity of the region and providing valuable insights that will help in the development of ecotourism initiatives.

I extend my deepest gratitude to the dedicated team from the Jigme Khesar Strict Nature Reserve for their tireless efforts in conducting this comprehensive survey and the Helvetas Bhutan for the financial support.

As we continue to develop Haa as a premier tourism destination, I hope that this report will inspire a deeper appreciation and respect for the natural world among all who have the privilege of exploring the Nubtshonapata Trek. Let us continue to work together to protect and cherish the treasures that our environment has bestowed upon us.

Kadrinche La!

(Damcho Rinzin)
DIRECTOR

Executive Summary

A comprehensive quantitative survey was conducted along the 21.3 km Haa Dranadingkha to Nubtshonapata Trek to assess and elucidate the diversity of flora and fauna for the promotion of nature-based ecotourism in Haa. The survey aimed to provide a comprehensive understanding of the biodiversity present in the region, which will serve as the foundation for sustainable tourism development, contributing to both conservation efforts and local economic growth. The survey spanned with elevations ranging from 3,278 to 4,400 meters covering Fir, Juniper and alpine habitat. A transect walk method was adopted systematically at intervals of 500 meters along the trail for flora and mammals but for birds Mackinnon listing method was adopted along the trail.

Key findings of the survey highlight the area's rich biodiversity, featuring a wide range of flora, including endemic and alpine medicinal plant species, as well as rare and threatened fauna. The region is home to numerous mammals and birds, with notable sightings of species of high conservation value such as the Snow leopard, Himalayan musk deer, and several bird species like the Himalayan monal. The survey result revealed a total of 282 plant species, representing a remarkable diversity spanning across 70 families, with a diversity index of 4.914. The Asteraceae family dominated with 39 species (14%), and the area is notable for its presence of White poppy species. Signs of 66 mammal species were recorded from 41 transect walks. The total sign encounter rate was 3.22 signs per kilometer, with a mean of 0.54 ± 0.66 signs per transect. 47 bird species were observed, distributed across 19 families. The Greenish Warbler was the most abundant bird species (11%, n = 26), followed by the White-browed Rose Finch (10%, n = 23), Olive-backed Pipit (7%, n = 17), and others such as the Blue-fronted Redstart, Black-faced Laughingthrush, and Spotted Nutcracker.

The results of the survey indicate a rich biodiversity along the trek, offering significant potential for ecotourism. The diversity of flora and fauna, particularly the abundance of bird species and the presence of rare plant species, enhances the trek's appeal to nature enthusiasts and wildlife observers.

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1. Introduction

The **Nubtshonapata** known as the "Great Lake of the West" is also referred to as the "Poppy Trek", is nestled within the heart of the Jigme Khesar Strict Nature Reserve, Bhutan's only strict nature reserve with altitudinal range from 3278m to 4200m. This trek offers a unique opportunity to explore the habitat of the elusive Snow leopard and endemic white poppy with diverse flora and fauna which covers 21.3 km from Haa Dranadingkha. Hidden in the folds of the Himalayas, Nubtshonapata Lake is considered sacred by Bhutanese people and the trek is the popular trek under Haa Dzongkhag. Historically, the trek dates back to biography of Terton Sherab Mebar (religious treasure revealer) and the mythical breed of cattle "Nublang". Such places of historical, cultural significance and diverse flora and fauna have great potential to draw tourists in the future and attract nature enthusiastic from within and outside the country. The Trek will offer many scenic and pristine sites of tourist interest and the most and beautiful rare white poppy species along the trail.

Therefore, the Haa to Nubtshonapata Trek is a significant route in Haa, celebrated for its pristine natural beauty and biodiversity. To enhance the trekking experience and promote eco-tourism, it is essential to document the diverse species of flora and fauna along the trail. This survey aims to systematically record and analyze the various plant and animal species, their abundance, flowering times, and other relevant ecological data. The survey conducted along the Haa-Nubtshonapata Trek, which is popularly known as the "Poppy Trek," documented the rich flora and fauna diversity that defines this captivating region. This trek, nestled within the breathtaking landscapes of the Haa mountains, offers tourists a unique opportunity to experience the vibrant biodiversity that flourishes in this area. The study highlighted the variety of plant species, including the iconic white poppy, and the diverse wildlife that inhabits the region, making it a must-visit destination for nature enthusiasts seeking to immerse themselves in the natural beauty and picturesque scenery of Haa that the Haa-Nubtshonapata Trek has to offer.

1.1 Objectives:

The specific objective of the survey is;

- ✓ Document flora and fauna diversity along the Haa-Nubtshonapata Trek.
- ✓ Provide valuable information for tourists as to promote nature-base ecotourism destination.

2. Materials and Methods

2.1 Study areas

Jigme Khesar Strict Nature Reserve was the lone nature reserve amongst the ten protected areas in Bhutan. The reserve is located in the Northern-western part of the country forming a pristine habitat for many wild flora and fauna connecting Hindu-Kush Himalayan region with Nepal, India and China (Figure 1). It also a part of Kangchenjunga Landscape and it forms a sacred Snow Leopard conservation landscape in the Eastern Himalaya, and the survey areas falls along the Haa-Nubtshonapata Trek which is also referred as the "Poppy Trek" spanning almost 21.3km trek.

Figure 1: Survey area Map Dranadingkha-Nubtshnapata Trek

2.2 Methods

The primary method for data collection was transect walks along the trekking trail which started from Haa Dranadingkha to Nubtshonapata (Figure 2). The following steps outline the procedure:

Transect Walks:

- ✓ Established transects along the trek route.
- ✓ Each transect was cover a specific distance of 500m, and observations was recorded from both the left and right sides of the trail (within 50m).

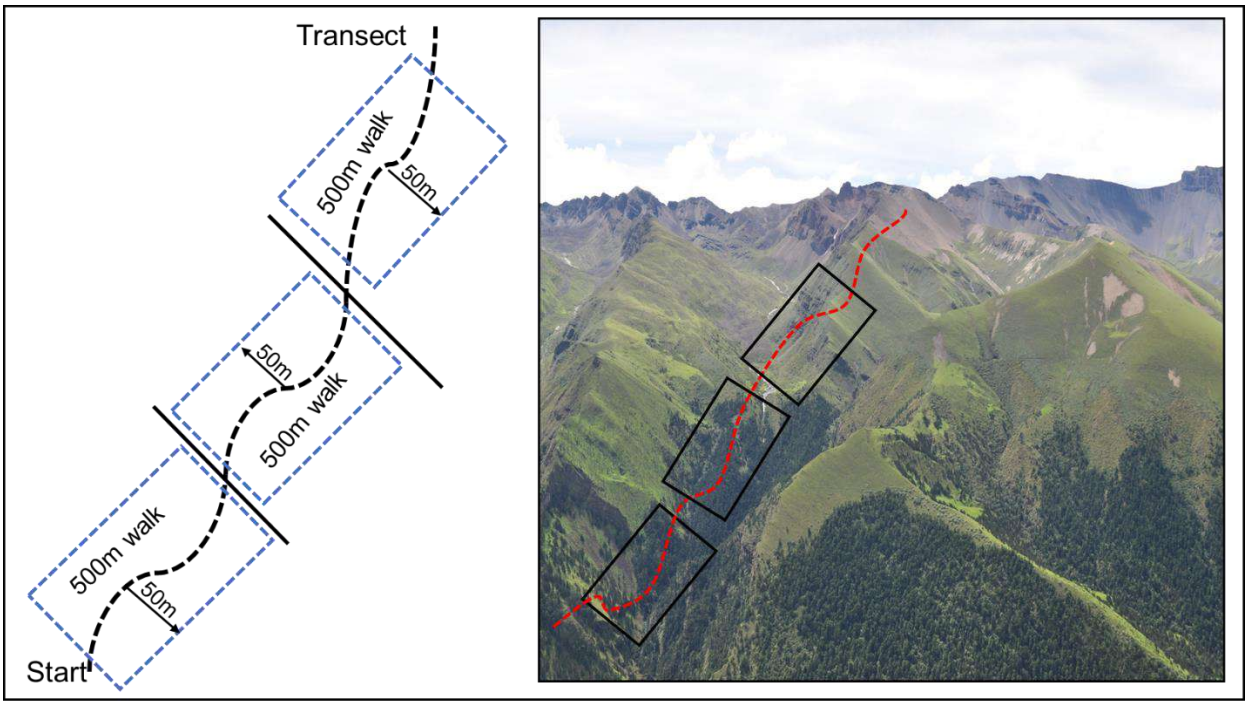

Figure 2: Survey sampling design

Data Collection Modality:

The data were collected using the survey form developed in the Epicollect5 and was guided by SW Maps mobile app. along the trail.

Flora (plants) Survey:

- ✓ Identified the plant species and recorded their abundance status.
- ✓ Noted the flowering time and any other relevant phenological data.

Fauna (mammals) Survey:

- ✓ Trail transects survey for mammals were used to record evidences/signs in every 500m transect walk covering habitat along the trek to calculate the evidences encounter rate per kilometer walk of a species (NCD, 2020).
- ✓ Identified animal species observed along the transects (Direct Sighting & Indirect Evidence) were recorded.

Fauna (birds) Survey:

Line transects are said to be the preferred survey methods for bird survey (Gibbons and Gregory, 2006). Within the survey area, MacKinnon Listing methods was adopted to investigate the abundance, species-area curve and diversity of birds with respect to the forest habitat types. A trail transect involves walking, observing, enumerating and recording all sightings along the trail of listing 5-5 methods was adopted. The bird enumeration data were collected and managed using the Epicollect5 mobile app.

1). Record the first 5 different bird species you detect.

2). After you finish your first list of 5 species, begin a second list of 5 species again.

- ✓ this second list is done the same way - record the first 5 different species you detect from the time you began the second list.
- ✓ the second list can repeat species you already recorded on the first list (each list is independent).

3). Continue making new 5-species lists until you have covered the survey area.

Equipment:

- ✓ GPS devices and SW map to record the exact location of observations (Geo location).
- ✓ Cameras for photographic documentation.
- ✓ Binoculars for bird survey.
- ✓ Field guide books for species identification.
- ✓ Digital devices for recording data (Epicollect5).

Epicollect5, Global Positioning System (GPS), compass, clinometer, measuring tape, herbarium press (plant press), altimeter, pencil, eraser, plastic file, digital camera, SW map, and SMART applications were used to collect the spatial data during survey. The nomenclature was followed by using Flora of Bhutan (Grierson and Long, 1983-2000), Flowers of the Himalaya (Polunin and Stainton, 1984), and Flowers of the Himalaya: a supplement (Stainton, 1988) and High-Altitude Medicinal Plants of Bhutan (Wangchuk, 2009).

2.3 Data Analysis

2.3.1 Flora Data Analysis

Species richness is the most common measure of diversity and is measured by simply counting the number of individuals along the transect. Species diversity index (H′) was calculated by using Shannon and Wienner Diversity Index whereas, species evenness (*J*) was calculated using Pielou's Evenness method, 1969. The volume estimate or relative biomass was used for the analysis of dominance or dominant species (Wangda et al., n.d).

In case of finding out species richness, evenness index and index of dominance, Shannon-Wienner index were used.

i). Shannon-Wiener index $$H' = - \sum_{i=1}^{s} pi \ln pi$$

Where;

$Pi = ni/N$

n_i = the number of individuals in species *i*, the abundance of species *i*.

N = total number of all individuals

S = the number of species which is also called species richness.

P_i = the relative abundance of each species, or proportion of species *i*

H′ value ranges between 1.5 to 3.5, with a value of 0 indicating that the area has only one species. Increasing value of H′ indicates increasing diversity.

ii). Species richness (S) = $\frac{(S-1)}{LogN}$,

Where *S* = total number of species; *N* = total number of individuals of all species

iii). Evenness index (J) = $\frac{H'}{Ln(S)}$

Where H' = Shannon Wiener diversity index; S = Total number of species (Species Richness).

Pielou's Eveness (J) indicates how evenly the species are distributed in the forest with values ranging from 0 to 1. A value of 0 indicates no evenness and 1 indicate complete evenness.

iv). Species dominance

v). Species accumulation/area curve

vi). Relative abundance

vii). Composition and Life-form

Data collected from the field was compiled and processed using PivotTable of the Microsoft Excel 2021 specifically the pivot table and PC-ORD version 5.1 was used for cluster analysis to determine the cluster solution using distance measure of Sorensen (Bray-Curtis) and Group Linkage Methods using Ward's or Group Average to determine the floristic species classification, graphs, figures were prepared. Not only cluster analysis, species area curve, species dominance and multivariate analysis were also done through PC-ORD 5.1. and R (version 4.4.1) to analyze the data, and GIS software (QGIS 3.34) was used for production of map of the study area.

2.3.2 Faunal Data Analysis

Data collected from the field was compiled and analyzed using Microsoft Excel 2021 specifically the PivotTable, and others for graphs, descriptive, figures and GIS software (QGIS 3.34) was used for mapping.

3. Results and Discussion

3.1 Floristic Composition and Life-form

The Haa Dranadingkha to Nubtshonapata Trek is a captivating journey through varied ecological zones, each showcasing distinct floristic compositions and species diversity that contribute to its breathtaking beauty and memorable experience. The transition from conifer forests to alpine meadows showcases a remarkable shift in floristic composition. The lower elevations with dense conifer forests provide a rich, green, and shaded environment, while the alpine zone offers a stark contrast with open, colorful meadows and hardy plants adapted to cooler conditions. This diversity not only enhances the ecological richness but also creates a visually stunning landscape. The trek's beauty is heightened by the contrast between the lush greens of the forest and the vibrant colors of alpine flowers against the backdrop of mountain landscape (Figure 3).

Figure 3: Blooming of alpine flowers at the Gongchela on the way to Nubtshonapata

3.1.1 Floristic Composition

The quantitative inventory of floristic composition, diversity, dominance, and distribution pattern of plant communities were assessed along the Haa Dranadingkha to Nubtshonapata Trek. A total of 282 species of plants belonging to 70 families were recorded from 75 transect over a distance of 21.3km within an altitude range of 3278 to 4400m. The data collection across various transects and elevations provides a comprehensive overview of the plant communities along the

trek. The large number of recorded species and families indicates high floristic diversity and reflects the varied ecological conditions present within the surveyed altitude range. The significant number of species and families contributes to a better understanding of plant community dynamics and biodiversity in this trek area. Among the recorded plant families along the Dranadingkha-Nubtshonapata Trek, the most dominant were Asteraceae (n = 39, 14%), followed by Rosaceae (n = 19, 7%), Primulaceae (n = 16, 6%), Ericaceae and Polygonaceae each represented 15 species (5%), and Ranunculaceae (n = 12, 4%), while Orchidaceae comprised 9 species (3%) and Scrophulariaceae (n = 8, 3%). Caryophyllaceae, Gentianaceae, Lamiaceae and Orobanchaceae each represented 7 species (3%), while Caprifoliaceae, Crassulaceae, Liliaceae, Pinaceae and Umbelliferae each had 5 species (2%). Additionally, 27 families were represented by a single species; Acanthaceae, Adoxaceae, Araceae, Betulaceae, Brassicaceae, Cruciferae, Dennstaedtiaceae, Dipsacaceae, Euphorbiaceae, Uvulariaceae, Valerianaceae and Zingiberaceae family (Figure 4).

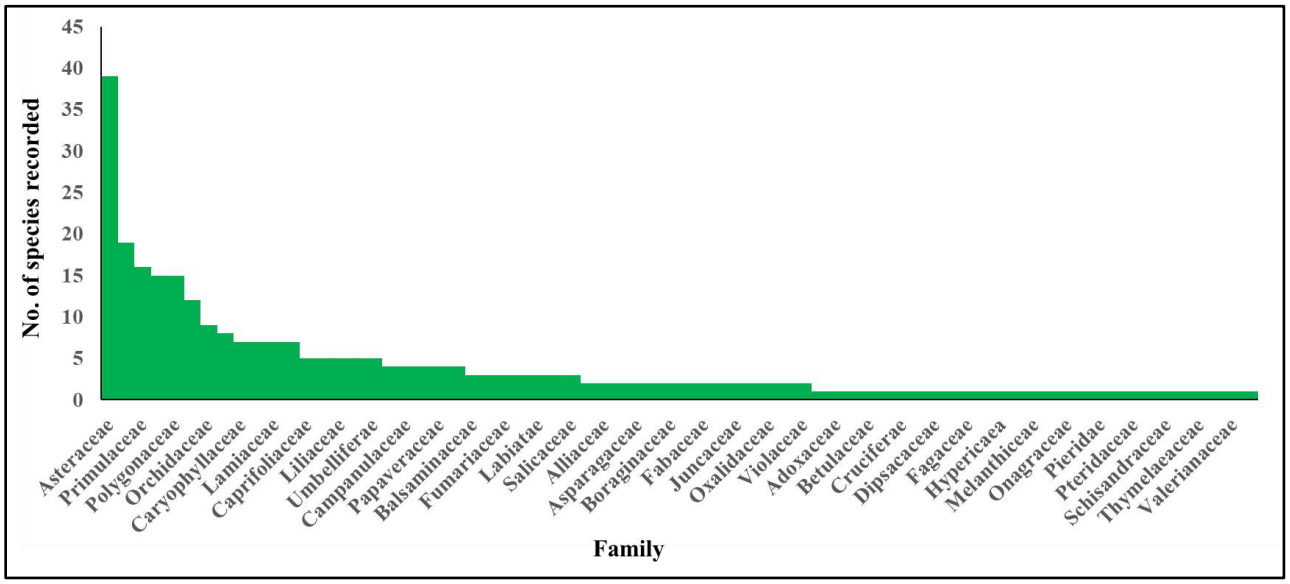

Figure 4: Number of plant species recorded under family

3.1.2 Species Diversity and Life-form

Generally, species diversity is one of the most important indices used to evaluate an ecosystem. A rich ecosystem with high species diversity has a large value (H′). The Shannon-Wiener index value of H′ = 4.914 suggests a high level of species diversity along the trek. This elevated index value indicates a rich and well-structured ecosystem with a balanced distribution of species. Such

diversity often correlates with ecological stability and resilience, as diverse communities are typically better equipped to withstand environmental changes and disturbances. The substantial species richness (n = 282) and evenness across the trek contribute to this high index value, reflecting a complex and robust plant community in the surveyed area.

This report evaluates the diversity and evenness of plant communities across different categories: herbaceous plants, coniferous trees, deciduous trees, and evergreen trees and shrubs. The Shannon-Wiener diversity index (H′), species richness (S) and species evenness (*J*) values were calculated to assess the variation in plant diversity and evenness (Figure 5 & 6).

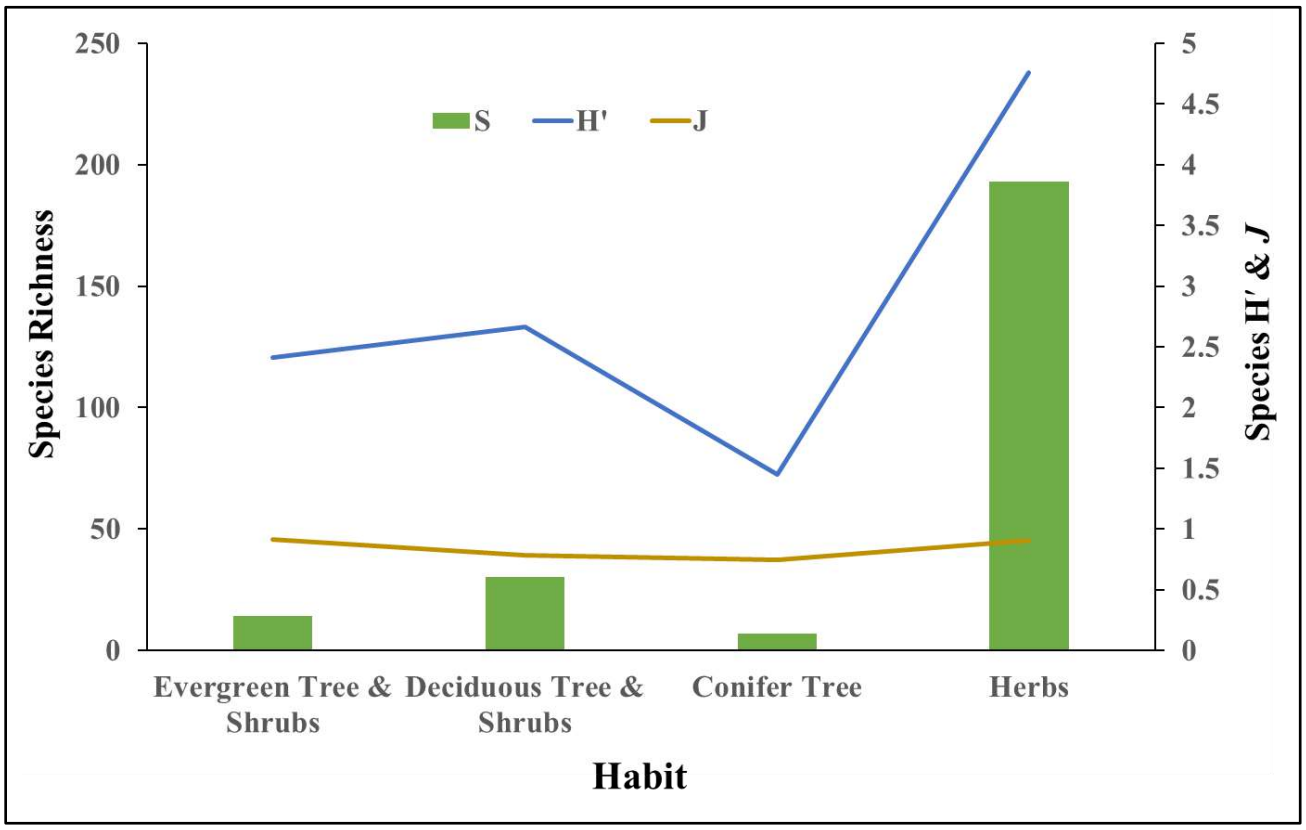

Figure 5: Species Diversity, Richness and Evenness in different plant habit

The diversity of herbaceous plants exhibited a higher level of diversity, as indicated by a Shannon-Wiener diversity index (H′) of 4.761 and a species evenness (*J*) value of 0.905, with a species richness (S) of 206 counts. In contrast, coniferous trees showed the lowest diversity, with an H′ value of 1.447, S value of 7 and a *J* value of 0.744. These variations in species richness and diversity can be attributed to factors such as topography, soil conditions, rainfall variation,

humidity, temperature, light, and moisture content (Ohsawa, 1987, 1991, 2002; Wangda and Ohsawa, 2006a; Wangda et al., 2010; Shaheen et al., 2011). The species evenness (*J*) values for different plant communities showed some similarities in the survey area ranged from 0.744 in conifers to 0.783 in deciduous trees, 0.905 in herbs, and reached the highest value of 0.913 in tree and shrub communities (Figure 5). Transect 1 and 2 which is located along the Dranadingkha to Tshokum in the Fir Forest has indicated higher diversity with a higher H′ value of 4.541 and 3.525 respectively with species richness (S) of 43 and 39 counts. The lowest diversity value of 1.012 along the transect 39 with S value of 18 species count along the Gongchela at altitude of 4185m and 1.267 along the transect 16 with S value of 13 species count was observed along the Chozula at altitude of 3925m (Figure 6). The diversity decreases when increase in altitude with less diversity at ridge top. Similar trend was observed by Chang-Fu et al., (1998); Bhattarai and Vetaas (2003) that species diversity decreased with increasing elevation.

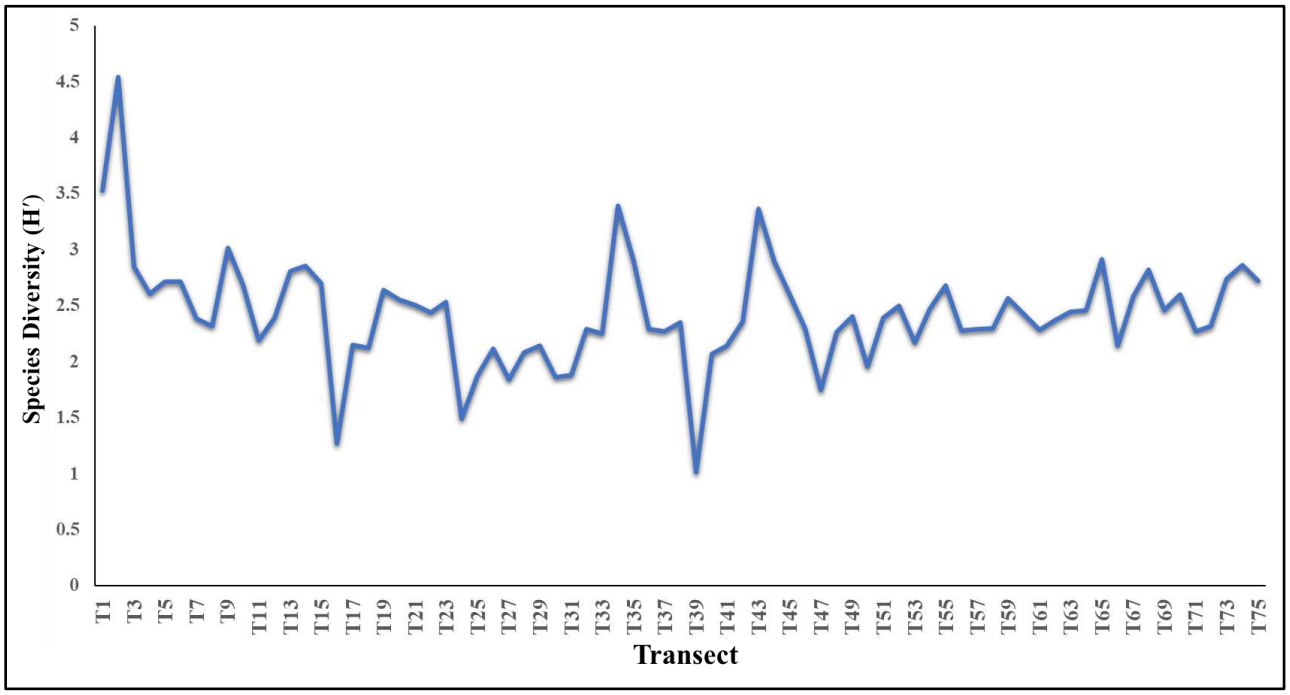

Figure 6: Species Diversity along the Transect

Floristically, the vegetation area along the trek were composed of different life-form of herbs (annual & perennial), shrubs (deciduous & evergreen), graminoid, climber, orchid, bamboo, fern and tree species (conifer & broadleaf). The plant composition was classified into different life-

form of which constituted herbs as maximum coverage with 73% (n = 206), shrubs with 15% (n = 42), orchid 3% (n = 9), conifer tree 2% (n = 7), broadleaf tree 2% (n = 6), and grass 2% (n = 5), fern and climber 1% each (n = 3) and least 0.4% (n = 1) of bamboo species (Figure 7).

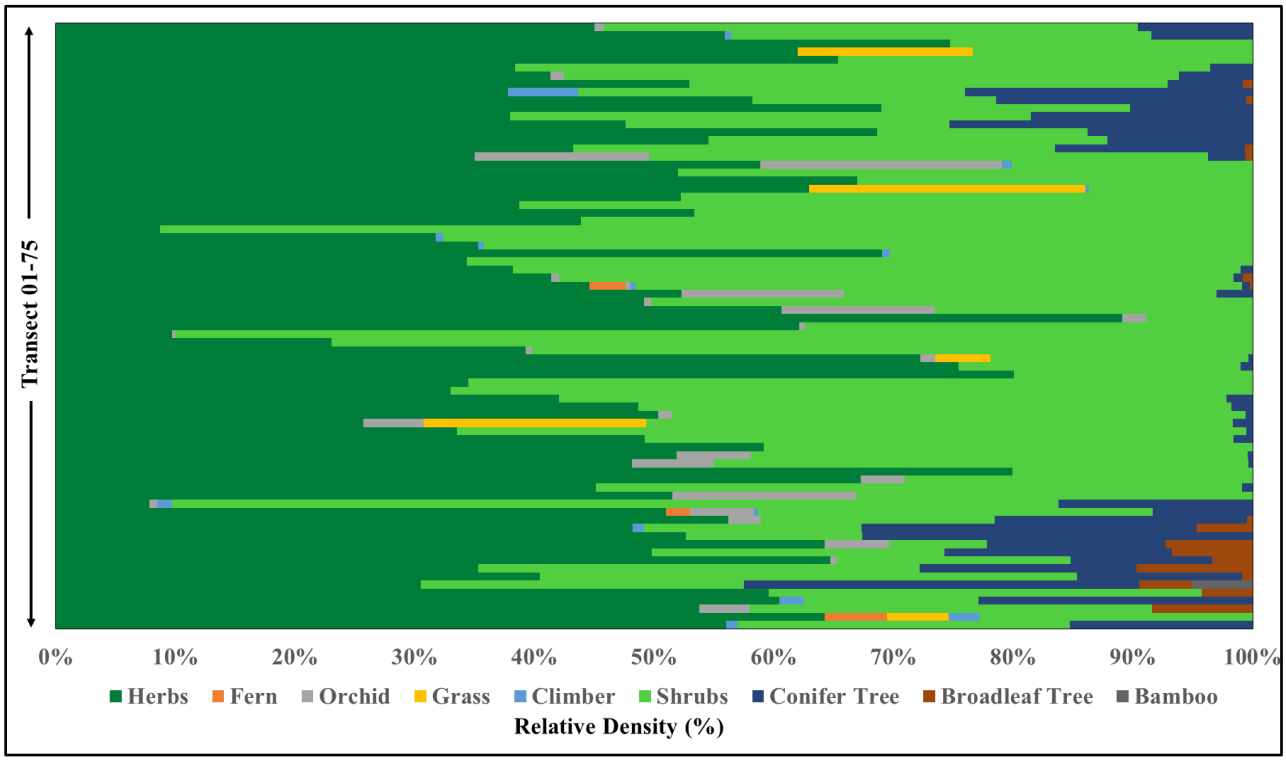

Figure 7: Composite of different Life-form along the transect

3.1.3 Species Accumulation Curve

The species-area curve was generated based on Relative Sorensen (Bray-Curtis Method) with 75 transect plots for 282 plant species did not flatten completely (Figure 8), indicating a requirement of few more sample plots to get all the diversity composition in the study area. The first-order jackknife estimates 373 species while the second-order estimates 418 species in the survey areas, the field assessment recorded only 282 species, which includes herbs, shrubs, orchid, grass conifer tree, deciduous tree, fern. The area curve suggests that we have not been able to determine the complete species or in other words given the time and resources, more species will be recorded in as we can infer from the curve that the curve is still moving up which indicate that the survey is incomplete. Of the total species recorded, 93 species showed only one occurrence, while 48 species showed two occurrences.

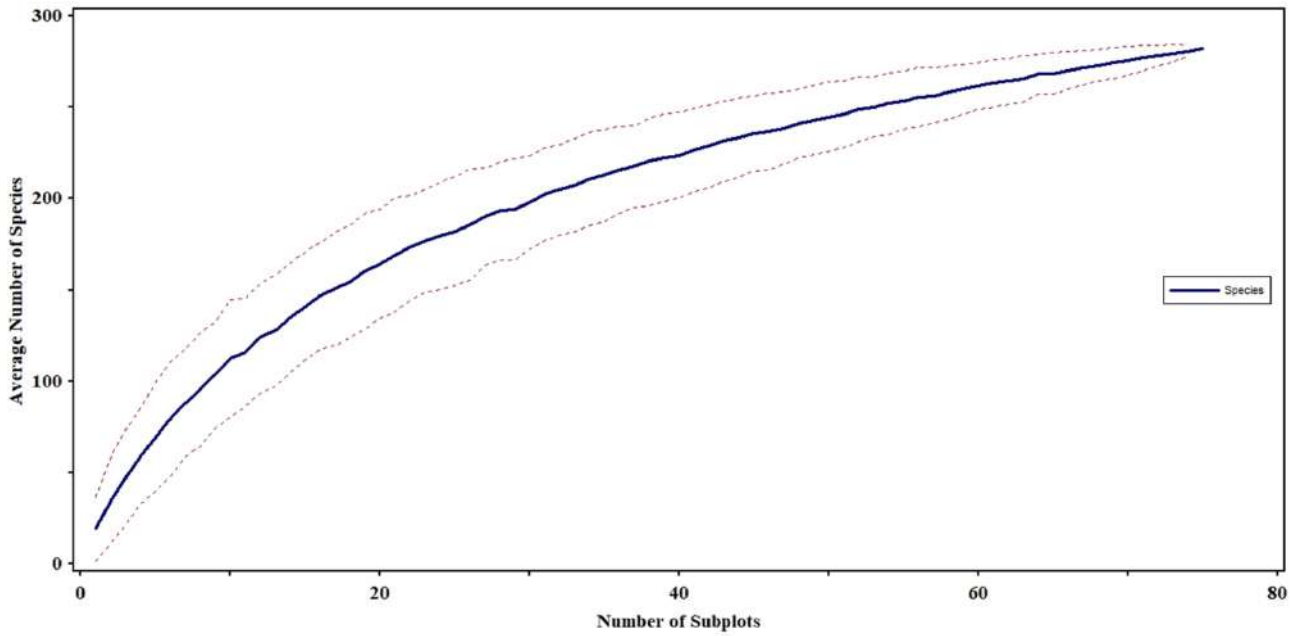

Figure 8: Species-area curve showing the likelihood of recording additional species by increasing the sample size.

3.1.4 Species Dominance along the Trek

The Relative Frequency (RF) percentage of individual species having the largest total biomass along the sampling plant community was used as abundance of species along the trekking route. The overall dominance diversity curve of each species at logarithmic sum computed based on relative abundance (Figure 9) shows the three most dominant species; *Rhododendron lepidotum* (10.872), *Rhododendron anthopogon* (9.211), *Rhododendron aeruginosum* (7.849), *Rhododendron setosum* (6.414) and *Bistorta macrophylla* (10.830), and the five least dominant species recorded were *Valeriana* sp. (1.524), *Notholirion macrophyllum* (2.710), *Primula longiflora* (3.060), *Impatiens glandulifera* (3.060), and *Platanthera* sp. (3.060).

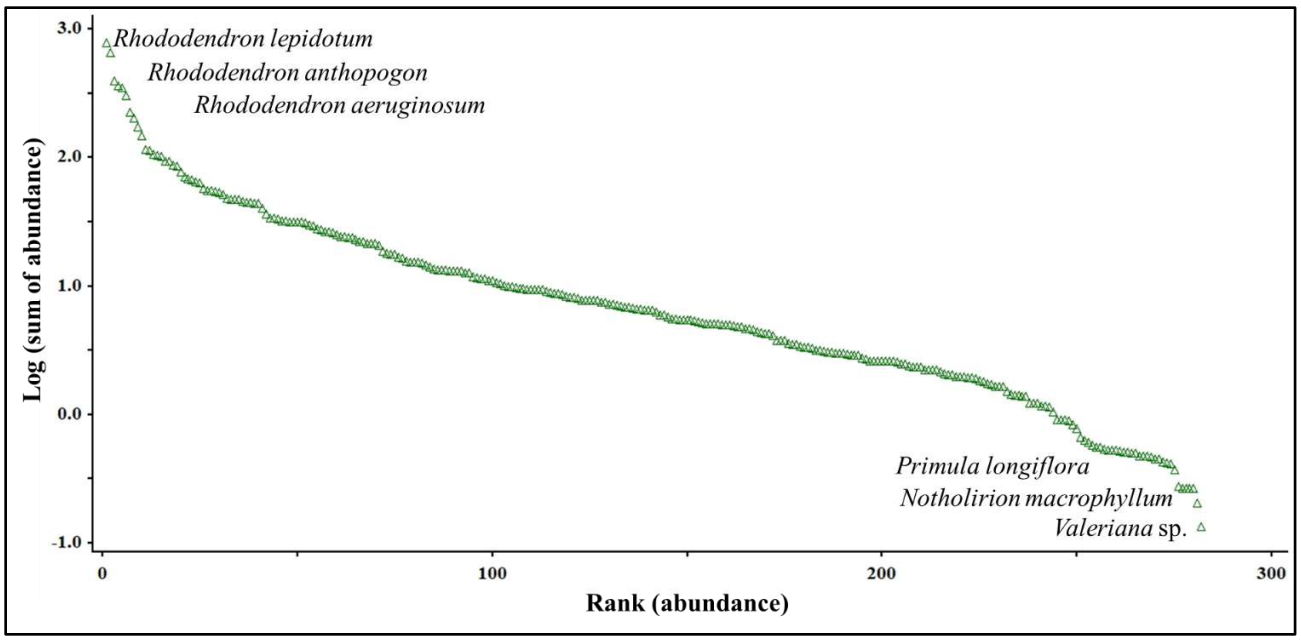

Figure 9: Dominance curve showing 282 species ranked according to the abundance starting with highest to lowest.

In terms of frequency, *Rhododendron lepidotum* was the most frequently observed species being recorded in all 56 transect (mean ± SD = 10.2649 ± 10.8723), followed by *Rhododendron anthopogon* in 50 transect (mean ± SD = 8.5645 ± 9.2106) and *Clematis montana* in 35 transect (mean ± SD = 4.5572 ± 10.8300). Of the total 282 species, 93 species (33%) were being recorded only once in every transect. This could be because they may have specific habitat requirements or be sensitive to particular environmental conditions that are not consistently present in the surveyed areas.

The Haa Dranadingkha to Nubtshonapata Trek, located in the breathtaking landscapes of Haa, is a paradise for alpine plant enthusiasts, offering a chance to discover a rich diversity of flora along the route. The journey begins in a mixed conifer forest, characterized by a wide variety of plant species, and gradually ascends into the fir zone, were rhododendron species flourish as undergrowth. From Chozula to Nubtshonapata, the trek traverses stunning alpine meadows, where a myriad of alpine flowers can be found (Figure 10). Among the highlights are the rare and beautiful White poppy (*Meconopsis superba*) and the endemic *Meconopsis elongata*, along with other captivating alpine species.

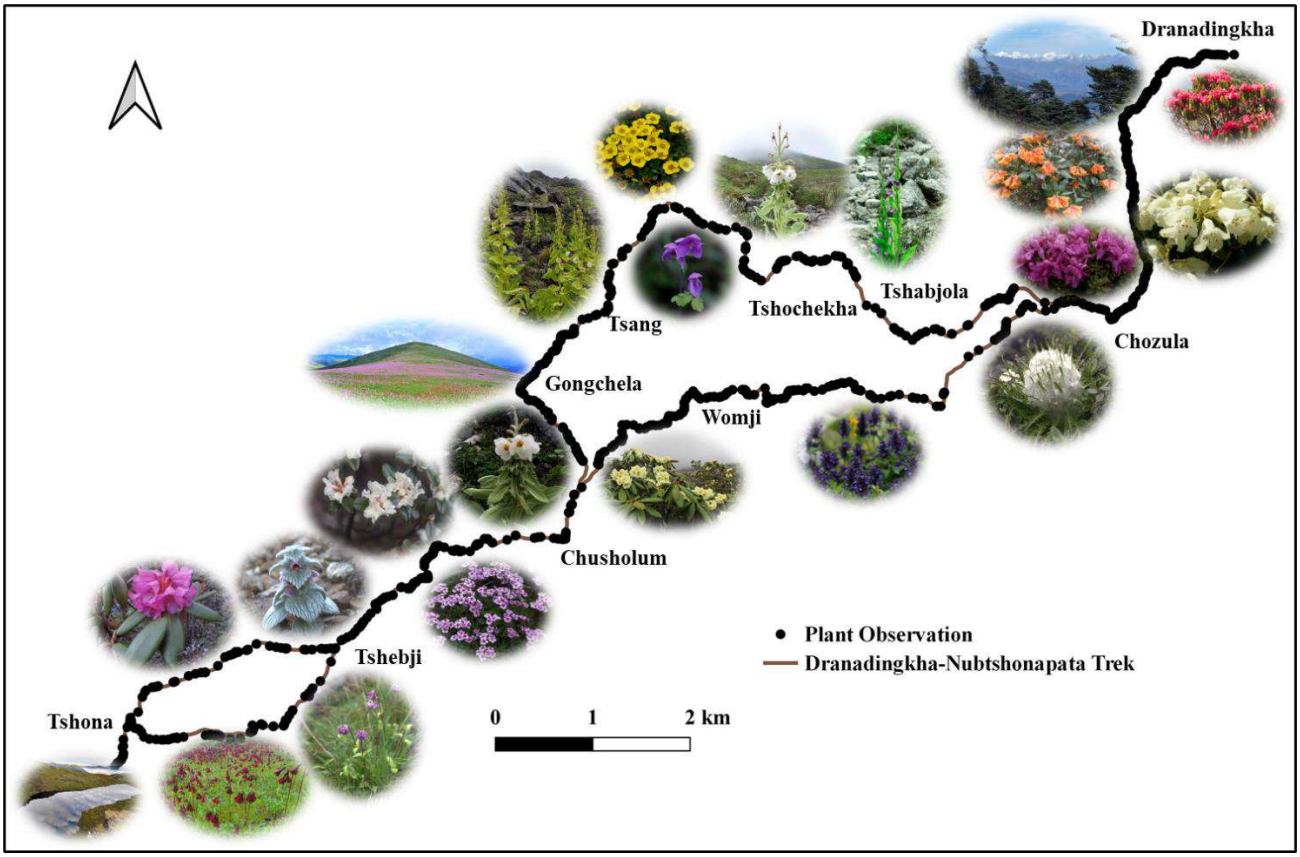

Figure 10: Mapping of Plants along the Haa Dranadingkha-Nubtshonapata Trek

3.1.5 White poppy along the Trek

Meconopsis superba commonly known as White poppy (Figure 11) is under Papaveraceae family, which is first described by French botanist named Viguier in 1814. Endemic to western Bhutan, Haa (Debnath and Nayar, 1986; Gyeltshen et al., 2020; NBC, 2014; Yoshida et al., 2016). The original locality, 'Ho-Ko-Chu' has sometimes been given as Chumbi, but is probably from the above district of Bhutan (Grierson and Long, 1984). It is an evergreen monocarpic perennial herb, which have rosettes of over wintering leaves. Its leaves are silvery colour and silky texture with finely toothed and not deeply lobed margins. Fat flowering stem arises from the rosette of leaves which have germinated from the last 3-5years. Single pediculate flower borne in the upper part of the flowering stem are white in colour, cup shaped with 4 or more than 4 petals and large purple-black stigma emerging through the dense boss of golden anther.

Figure 11: White poppy in their natural habitats

It grows in wet areas on rocky slopes, stony open gulleys or rock fissures of alpine scree above tree-line along the stream as a riparian plant within the altitude range of 3973-4366m. In the survey area at Tshochekha (27.374638^{0}N; 89.213305^{0}E), Yakuna (27.374672^{0}N; 89.209483^{0}E), Tsang (27.369344^{0}N; 89.182636^{0}E) and Chusholum (27.348466^{0}N; 89.168767^{0}E), the assessment of white poppy phenology revealed the majority of the plants were in the flowering stage (n = 52), They flower during the month of Mid-June to July in its native habitats during wet summer monsoon, rooting among rocks or gravel with scanty soil.

White poppy occurs mostly around areas that are facing south east or south with rocky slopes and gravel with scanty soil along streamside. Correlation between white poppy was assessed based on the relative abundance with associate species. White poppy abundance was highly correlated with occurrence of *Bistorta macrophylla* (0.4611), *Heracleum nepalensis* (0.1280), *Cassiope fastigata* (0.0248), *Aster* sp. (0.0260), *Pedicularies* sp. (0.0350), *Peurospermum* sp.

(0.0092) and *Saxifraga* sp. (0.0280). Spearman's rho correlation was also tested to evaluate the association of these environmental attributes. The result revealed high correlation between habitat and species diversity, $r = .435$, $p < .05$, indicating high diversity in rocky outcrop in the white poppy growing areas. Moreover, white poppy height correlates with soil temperature, $r = .355$, $p < .05$ which indicate growth of plants is influenced by soil temperature. The maximum height of M. *superba* of 200cm was recorded at Chusholum at 4146m facing south east and the minimum height was 50.33cm at above Tsang camp site (4206m) facing south west slope. However, the association between density against aspect was negatively correlated, $r = -.167$, $p < .05$. The white poppy is known for its stunning flowers that can change colour during the blooming process, transitioning from white to pink and eventually to a vibrant red (Figure 12). The colour-changing phenomenon is influenced by various factors, including environmental conditions, genetics, and the plant's life cycle. However, it's important to note that these colour changes are not uniform across all individual plants and can vary depending on the specific environmental conditions and genetic makeup of each plant. The remarkable ability of *Meconopsis superba* to change its flower colour can add to its appeal and uniqueness, making it a captivating sight in the mountainous regions where it grows.

Figure 12: White poppy in different flower colour (white, pink and red)

Jigme Khesar Strict Nature Reserve harbors eight Meconopsis species viz. *Meconopsis superba*, M. *paniculata*, M. *simplicifolia*, M. *elongata*, M. *horridula*, M. *ploygonides*, M. *wallichii* var. Fusco-Purpurea, and M. *primulina* (JKSNR, 2018). Promisingly, almost 60% of the reserve area provides a suitable habitat to M. *superba*, thus, requiring special conservation efforts. However, *Meconopsis superba*, M. *paniculata*, M. *simplicifolia*, M. *elongata*, and M. *horridula* are seen along the Trek in different location (Figure 13).

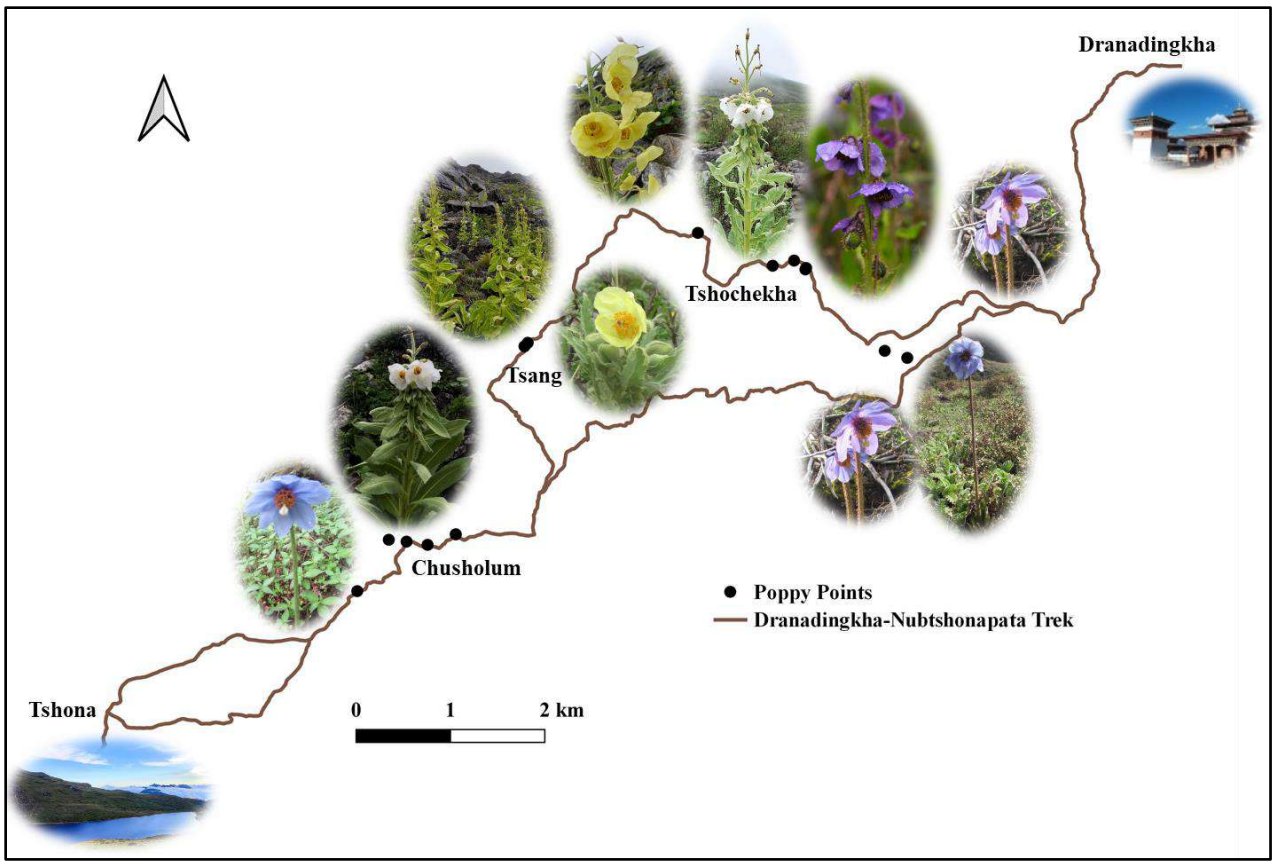

Figure 13: Mapping of Poppy along the Haa Dranadingkha-Nubtshonapata Trek

Among the species; *Meconopsis superba* and *Meconopsis elongata* is a large poppy species which grows in the high mountains and is endemic to Bhutan and as well as to the reserve. The species is believed to be native to Bhutan and has more occurrences and density under the reserve area, Haa dzongkhag. *Meconopsis elongata* found alongside *Meconopsis superba* at Tshochekha 27.374705^{0}N; 89.213276^{0}E) at 4135m, is unique to a single location along the Nubtshonapata Trek. This species is grown in West- or South-facing rocky slopes, stony open gulleys or rock fissures above tree-line exposed to wet summer monsoon rains; rooting among rocks or gravel with scanty soil. This species was first described in 2016 by botanists Toshio Yoshida, Rinchen Yangzom, and David G. Long after their exploration of the site. Their research, published in the Plantsman series under the paper titled "The Opening of an Area of Bhutan to Tourists Has Resulted in the Discovery of a New Blue Poppy," introduced *Meconopsis elongata* (Figure 14) as a newly recognized species. A research paper described; A Japanese tour group was permitted to visit the western highlands of the district in the summer of 2006 and then

in 2013. Hideo Takahashi, a member of that group, photographed some plants of Meconopsis, including M. *superba* in the year 2013. These photographs showed that this species was still surviving in Haa, 57 years since Frank Ludlow and George Sherriff collected the plant in the same area in 1949 stated the report. Since then, many tour groups from Japan and other countries have visited the highlands of Haa and photographed plants of Meconopsis, as well as many other alpine plants (Yoshida et.al., 2016).

Figure 14: *Meconopsis elongata* at its type locality at Tshochekha along the trek

3.2 Avi-Fauna Diversity and Composition

3.2.1 Bird Diversity

Out of the 144 bird species documented in the alpine habitat during the RBA survey in the year 2021, 47 species under 19 families were recorded along the transect within an eight-day survey period (16^{th} – 23^{rd} July, 2024). The calculated diversity index (H') indicate that species diversity was highest in the Fir Forest (H' = 3.097), followed by the Alpine habitat (H' = 2.903), Mixed Conifer Forest (H' = 2.554), and Juniper Forest (H' = 2.164) (Figure 15). The greater species diversity observed in the Fir and Alpine habitats is likely due to the fact that a significant portion of the transect traverses these habitats.

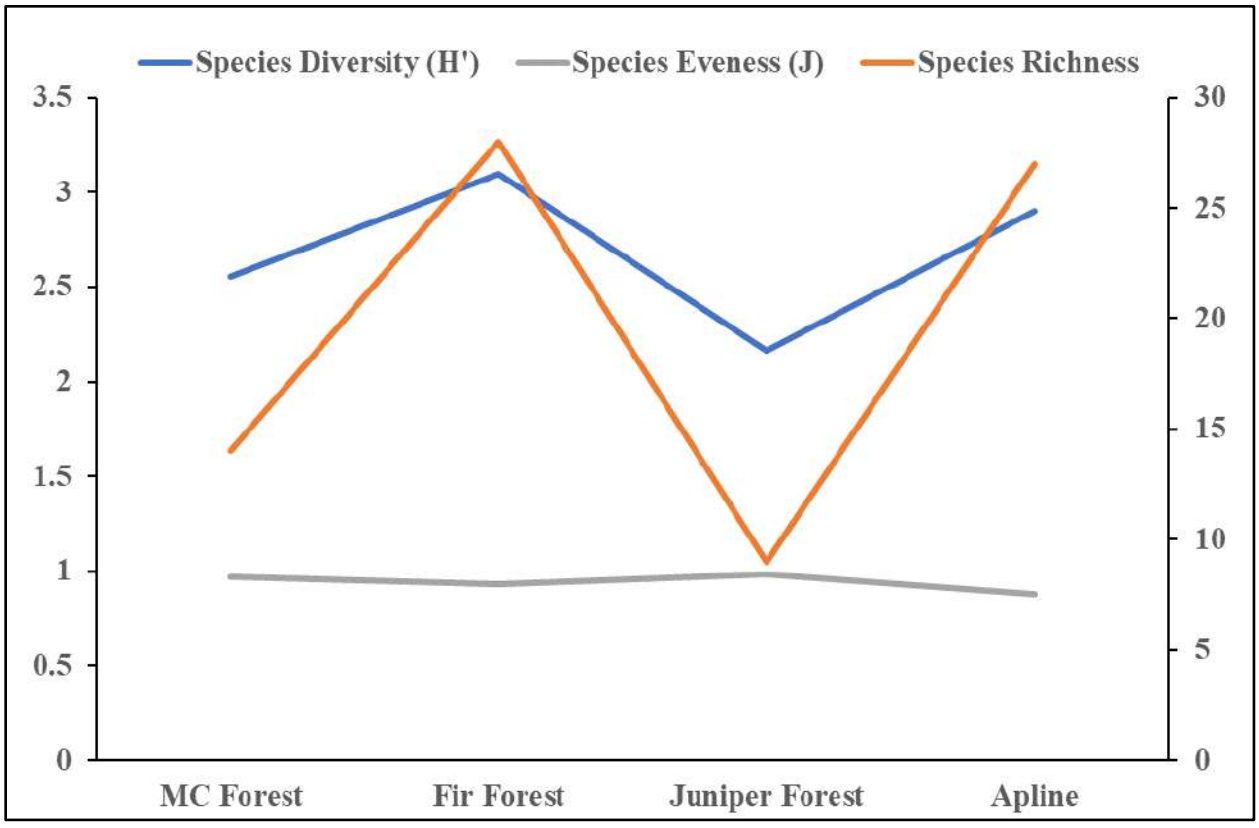

Figure 15: Birds diversity in different habitat zone

3.2.2 Species Area curve

Species richness is the total bird species diversity reached no new species are recorded in a new succeeding list or when the species richness curve runs parallel to the x-axis. It is thus assumed as the total number of bird species found at any habitat at that particular time of survey. A particular habitat will show different species richness during different seasons mainly due to the altitudinal migratory patterns of the birds. The Mackinnon listing results have documented a total density of 235 bird counts across 47 running lists (Figure 16). While these findings provide a significant snapshot of avian diversity present along the trek, highlighting a variety of bird species. However, the findings also indicates that the complete species richness has not yet been fully determined. This is due to the short duration of the survey and the fact that it was conducted only once over an eight days period (16^{th} – 23^{rd} July), the species accumulation curve has not yet been fully determined. This limited timeframe likely contributed to an incomplete representation of the bird species present in the area. As a result, the true extent of avian diversity along the trek remains partially obscured, suggesting that a more prolonged and repeated survey effort would be necessary to accurately map the species accumulation curve and capture the full richness of the bird population along the trek.

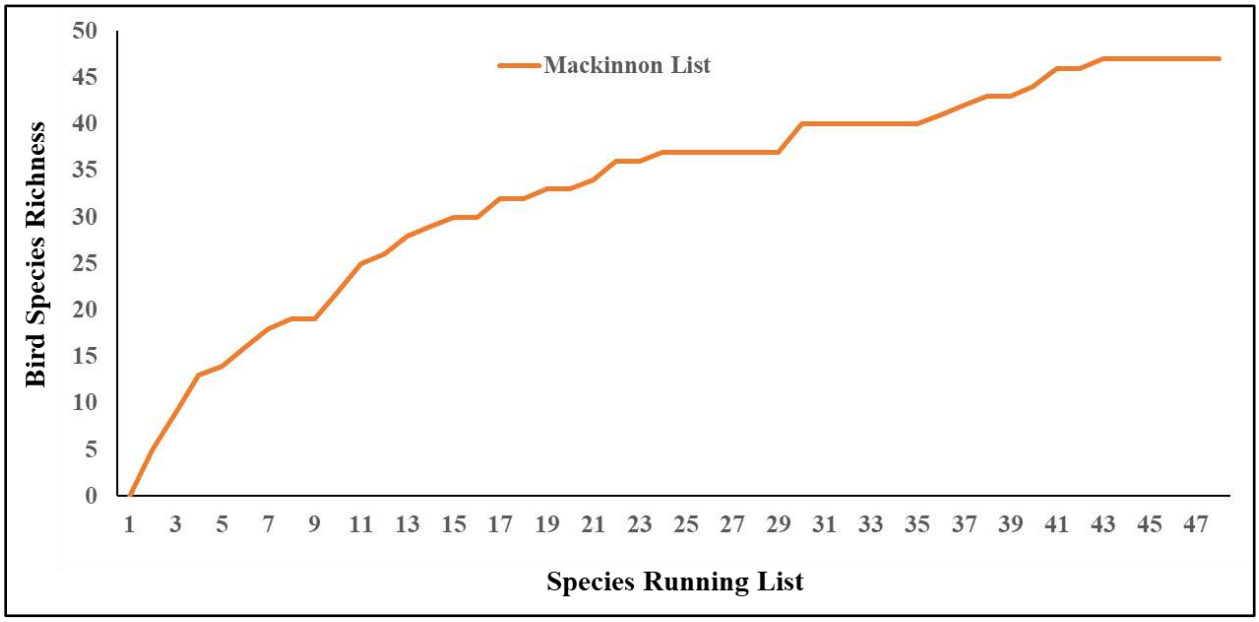

Figure 16: Species Richness Accumulation Curve for 47 running list

For the four major habitat types covered during the survey, species richness frequency curves were generated using the species total as the function of the bird diversity of each vegetation type surveyed from the number of lists of that habitat type. The Alpine habitat recorded the highest bird density, with 145 species observed across 29 running lists. This was followed by the Fir Forest, where 60 species were documented in 12 lists, the Mixed Coniferous Forest (MC) with 20 species in 4 lists, and the Juniper Forest, which had the lowest count, with 10 species recorded in 2 lists. In all habitat types, the consistent addition of new species in successive lists, even in the final ones, indicates that the complete species richness has not yet been fully determined. This suggests that with additional time and resources, more bird species are likely to be recorded across all habitats. The species richness curve further implies that the Alpine habitat may see fewer new species after a list or two, as the curve begins to flatten between the 6th to 9th and 24th to 28th lists. In contrast, the trekking trail suggest that the survey remains incomplete, and further exploration is needed to capture the full diversity of bird species (Figure 17). This suggests that with additional time and resources dedicated to the survey, it is likely that more bird species would be identified along the trek. The current results, though valuable, underscore the potential for even greater bird discovery in future assessments.

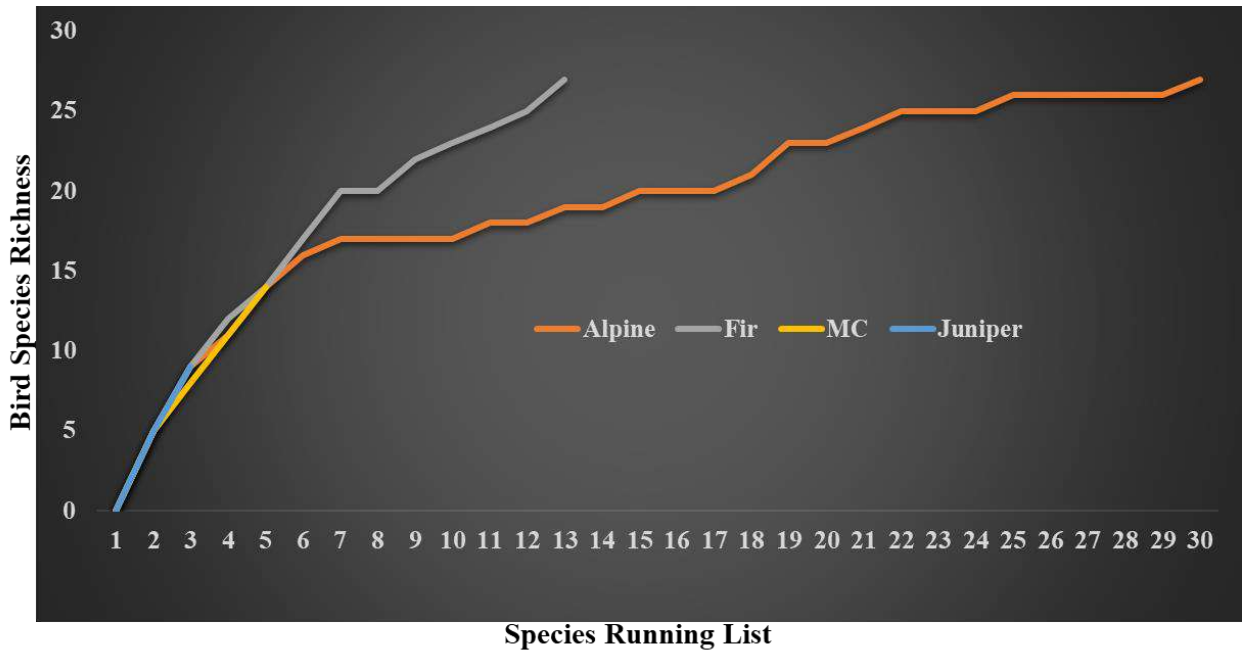

Figure 17: Species Richness Accumulation Curve for four major habitats

3.2.3 Relative Abundance

Based on the percent relative abundance computation, the most abundant bird species recorded along the trek were Greenish Warbler (11%, n = 26), White-browed Rose Finch (10%, n = 23), Olive-backed Pipit (7%, n = 17), Blue-fronted Redstart (6%, n = 15), Black-faced Laughingthrush and Spotted Nutcracker (each 5%, n = 12), Red-billed Chough (5%, n = 11) and Rosy Pipit (4%, n = 10) (Figure 18). The variation in the relative abundance of bird species across different habitat type is likely influenced by factors such as food availability, habitat conditions, and breeding seasons, the timing and season of the survey, as well as altitudinal gradients, edaphic factors and climatic conditions. Karr (1976) related the seasonality in the number of bird species within the availability of resources such as food and vegetation strata. Similar result was also obtained by Girma and Afework (2008) who reported positive correlation between bird species richness and the availability of vegetation strata, Similarly, Chance et al., (2006) reported that birds respond to changes in vegetation composition and structure, which in turn affects their food resources.

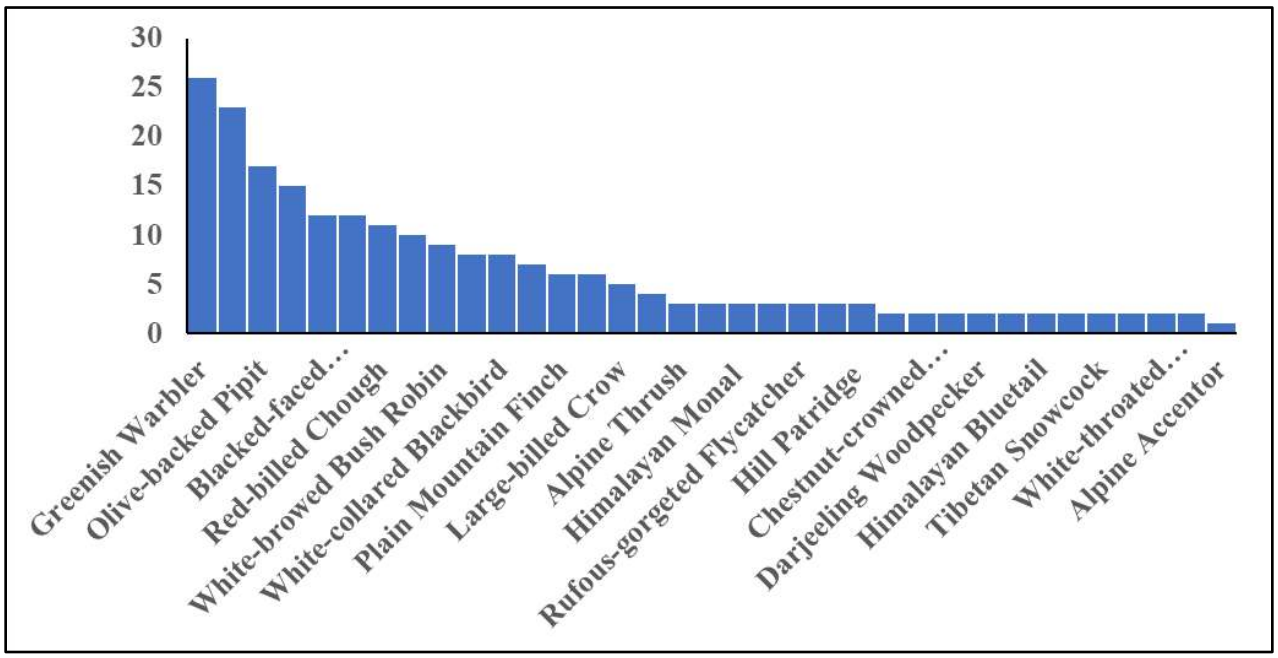

Figure 18: Relative abundance of bird species recorded along the trek

Winter migratory bird species are typically observed in the lakes and streams along the trek, adding to the avian diversity during the colder months. However, during the survey period, these migratory species were not recorded. This absence is likely due to the timing of the survey, which took place outside the typical migration season, preventing the documentation of these species that would otherwise be present in the area during winter.

The most dominant family recorded during the survey was Muscicapidae, representing 15% of the total species recorded (n = 7). This was followed by Fringillidae at 13% (n = 6), Phasianidae at 11% (n = 5), and Corvidae, Leiotrichidae and Phlloscopidae each comprising 9% of the total species (n = 4). Additionally, single species were recorded from the families Certhiidae, Columbidae, Hirundinidae, Laniidae, Paridae, Passeridae, Picidae, Pneopygidae and Cinclidae (Figure 19).

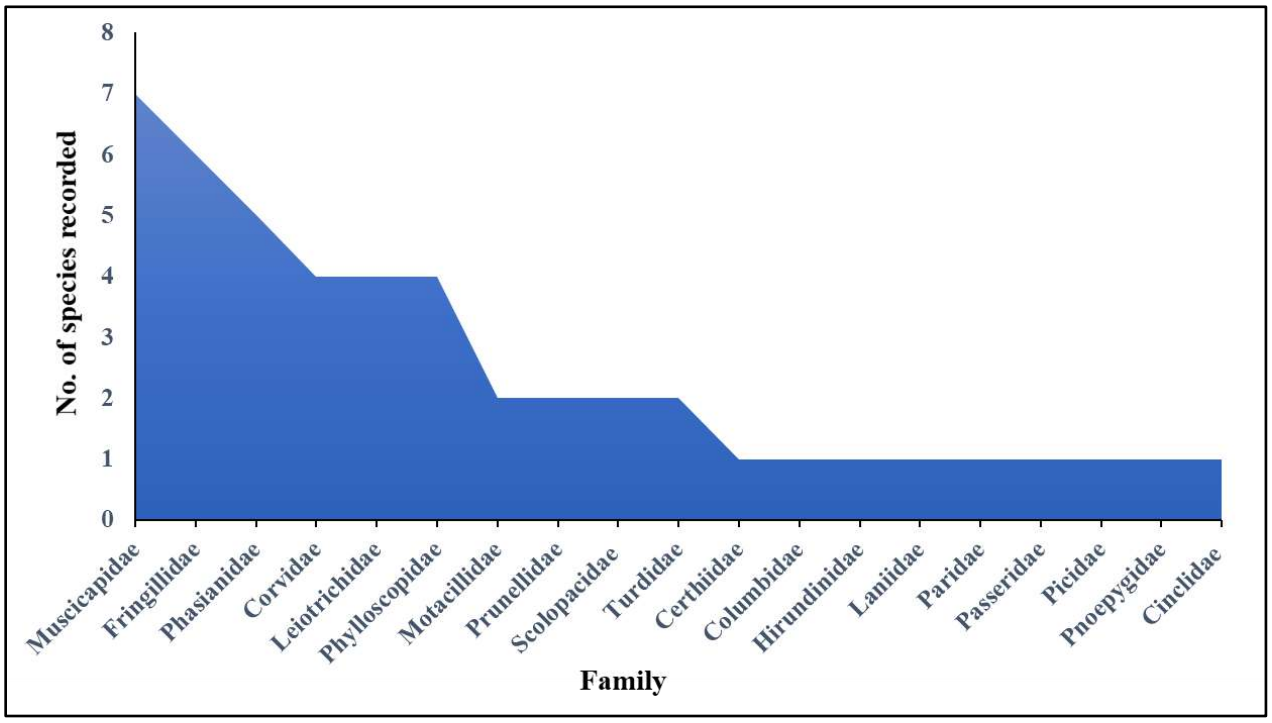

Figure 19: Record of species in each family along the transect

3.2.4 Mapping of birds along the trek

The Dranadingkha to Nubtshonapata Trek, situated within the stunning landscapes of Haa, offers an exceptional opportunity for birdwatching enthusiasts to explore a rich diversity of avian species (Figure 20). The first trek, which spans from Dranadingkha to Chozula, takes adventurers through varying altitudes ranging from 3278m to 3900m, predominantly within the Fir Forest. As you traverse through the cool, serene Fir forests from Dranadingkha till Chozula and along the Womji area, you will encounter a remarkable array of bird species, like Large-billed Crow, Greenish Warbler, Grey Bushchat, Yellow-billed Blue Magpie, Spotted Nutcracker, Himalayan Bluetail, Hill Partridge, White-collared Blackbird, Spotted Laughingthrush, White-browed Bush Robin, Rufous-gorgeted Flycatcher and Collared Grosbeak each adding to the natural symphony of the surroundings. The Fir forests along this trek are not just home to these bird species but are also a sanctuary of tranquility and natural beauty. The cool, crisp air, combined with the rich biodiversity, makes for an unforgettable experience. Birdwatchers and nature lovers alike will find themselves immersed in the pristine environment, where each bird sighting adds to the wonder of this extraordinary landscape.

The trek from Chozula to Nubtshonapata is also an extraordinary journey through pristine alpine habitat, where the elevation ranges from 3,900 meters at Chozula to a peak of 4,400 meters before descending to 4,200 meters at Nubtshonapata. This route offers not only stunning landscapes but also a unique opportunity to observe a rich variety of bird species that thrive in these high-altitude environments. As you begin your ascent from Chozula at 3,900 meters, the landscape transitions into a beautiful alpine zone characterized by rugged terrain, sparse vegetation, and expansive views of the surrounding mountains. The alpine meadows and rocky outcrops provide an ideal habitat for several iconic bird species. One of the most sought-after birds in this region is the Himalayan Monal, known for its vibrant, iridescent plumage. As you reach higher altitudes, the chances of spotting this magnificent bird increase, particularly in the early morning when they are most active.

At elevations around 4,000 to 4,300 meters, you may encounter the Snow Partridge and Tibetan Snowcock, both of which are well adapted to the harsh, cold environment of the high Himalayas. These birds are often seen foraging on the ground in small groups, blending in with the rocky terrain. The trek also offers sightings of smaller, yet equally fascinating species like Rosy Pipit,

Plain Mountain Finch, Olive-backed Pipit, Alpine Thrush and Alpine Accentor are common in the grassy slopes and alpine meadows. The Golden Bush Robin, with its striking golden-yellow plumage, and the White-winged Grosbeak is another highlight, often found flitting among the bushes and low vegetation. As you ascend further, the elusive Solitary Snipe and Common Greenshank may make an appearance near alpine streams and wetland areas.

The trek from Chozula to Nubtshonapata offers bird enthusiasts an unparalleled opportunity to witness the unique avifauna of the high Himalayas. The combination of the breathtaking alpine landscape and the diversity of bird species makes this trek a truly unforgettable experience for nature lovers.

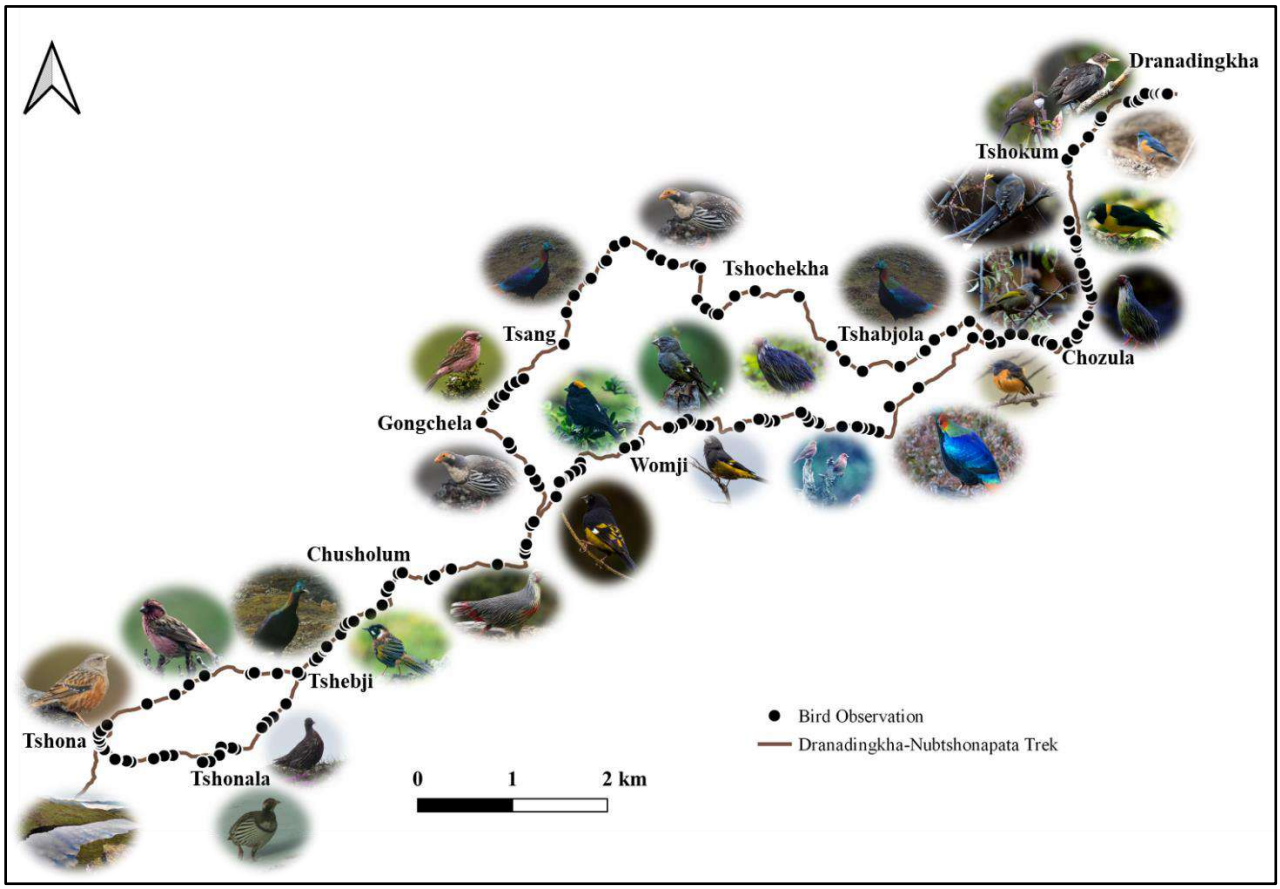

Figure 20: Mapping of Birds along the Haa Dranadingkha-Nubtshonapata Trek

Whether you are a seasoned birder or a casual nature enthusiast, the Dranadingkha to Nubtshonapata Trek offers a unique and enriching experience, with its remarkable birdlife being one of the many highlights of this journey.

3.3 Mammals Diversity

Mammals often leave behind signs that indicate their presence such as tracks, scats, dung piles, pellets, hairs, scent marks, scrapes, etc. that can be easily seen during the survey. Therefore, trail transects survey for mammals were used to record evidences/signs in every 500m transect walk covering major habitat types along the transect to calculate the evidences encounter rate per kilometer walk of a species (NCD, Biodiversity Monitoring Protocol, 2020). A total of 66 animal signs were observed along the 41 transect walk covering 20,500 meters (21.3km). The total sign encounter rate, calculated as the total number of signs per kilometer walk, was 3.22 signs/km, with a mean (mean ± *SD* = 0.54 ± 0.66). The Dranadingkha-Nubtshonapata trek, with its relatively high encounter rate of 3.22 animal signs per kilometer, suggests that the area is rich in wildlife (Figure 21). This makes it an attractive destination for tourists, particularly those interested in nature, wildlife observation, and ecotourism. Here are some specific reasons why this trek would be appealing:

High Biodiversity: The observation of 66 animal signs over a 21.3 km stretch indicates a diverse and active wildlife presence. Tourists, especially wildlife enthusiasts, are likely to find this trek rewarding, as they have a good chance of encountering various species along the way.

Ecotourism Potential: The encounter rate provides a quantitative measure of the area's biodiversity, which is a critical factor in promoting ecotourism. The data suggests that the trek offers an immersive experience in nature, with ample opportunities to observe wildlife in their natural habitat.

Educational and Conservation Value: For tourists interested in conservation and environmental education, the trek offers a living laboratory to learn about local wildlife, ecosystems, and the importance of preserving natural habitats. The data on animal sign encounters can also be used to promote conservation awareness among visitors.

Unique Experience: The variability in the encounter rate (as indicated by the SD of 0.66) suggests that different sections of the trek may offer different wildlife viewing experiences. This adds an element of surprise and uniqueness to the trek, making it more appealing to repeat visitors.

The scientific data supports the idea that the Haa Dranadingkha-Nubtshonapata trek is a valuable destination for wildlife enthusiasts, nature lovers, and eco-conscious tourists. The relatively high

encounter rate of animal signs indicates a thriving ecosystem that offers rich and varied experiences for visitors.

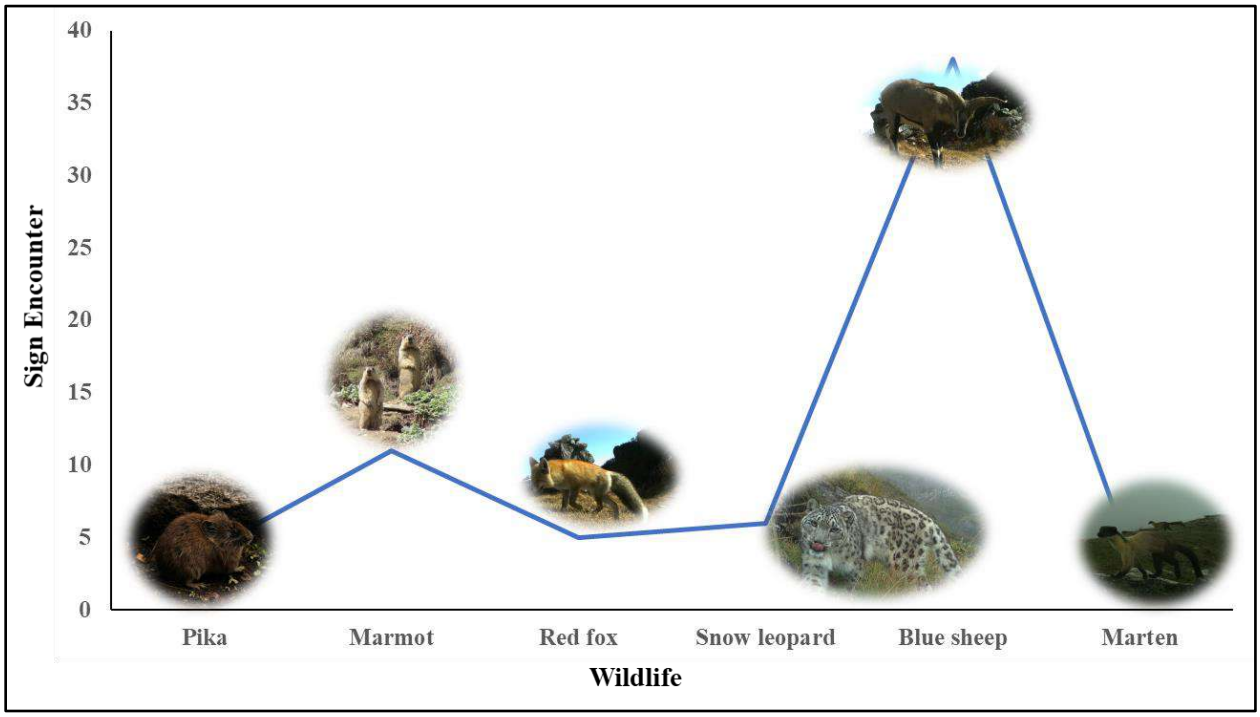

Figure 21: Wildlife sign encountered along the trek

3.3.1 Mapping of mammals along the trek

The Haa Dranadingkha to Nubtshonapata Trek is a breathtaking journey through one of Bhutan's most stunning and remote landscapes. This trek offers nature lovers a rare opportunity to explore a region rich in biodiversity, with a special emphasis on the diverse range of mammals that inhabit this pristine environment (Figure 22). One of the most exciting aspects of this trek is the high possibility of encountering some of the Himalayas' most elusive and iconic mammals. The Snow leopard, known as the "queen of the mountains," roams these high-altitude regions. Though sightings are rare and often a matter of great luck, the possibility of glimpsing this magnificent predator is a thrilling prospect for trekkers. The Blue sheep, is another remarkable species you may encounter in group along the trek. These agile herbivores are well adapted to the rocky slopes of the Himalayas and are a primary prey for the Snow leopard. Their presence is often an indicator that a Snow leopard might be nearby. As you continue your journey, you may also come across the Himalayan marmot, a large, burrowing rodent that is often seen basking in

the sun near its burrows. Their playful behavior and distinctive whistles add to the charm of the landscape. The Red fox, with its striking reddish coat, is another common sight along the trek. These intelligent and adaptable animals are often seen hunting for small mammals or scavenging for food in the more open areas. In addition to these species, the trek offers opportunities to observe other mammals such as the Musk deer, Himalayan serow, and even the elusive Pika, a small, rabbit-like creature that inhabits the rocky outcrops along the Trek.

The diverse mammal life along the Haa Dranadingkha to Nubtshonapata Trek, combined with the stunning landscapes, makes this trek a paradise for nature lovers. Every step of the journey offers the chance to connect with Haa's wild beauty, bringing immense joy and a deep appreciation for the natural world.

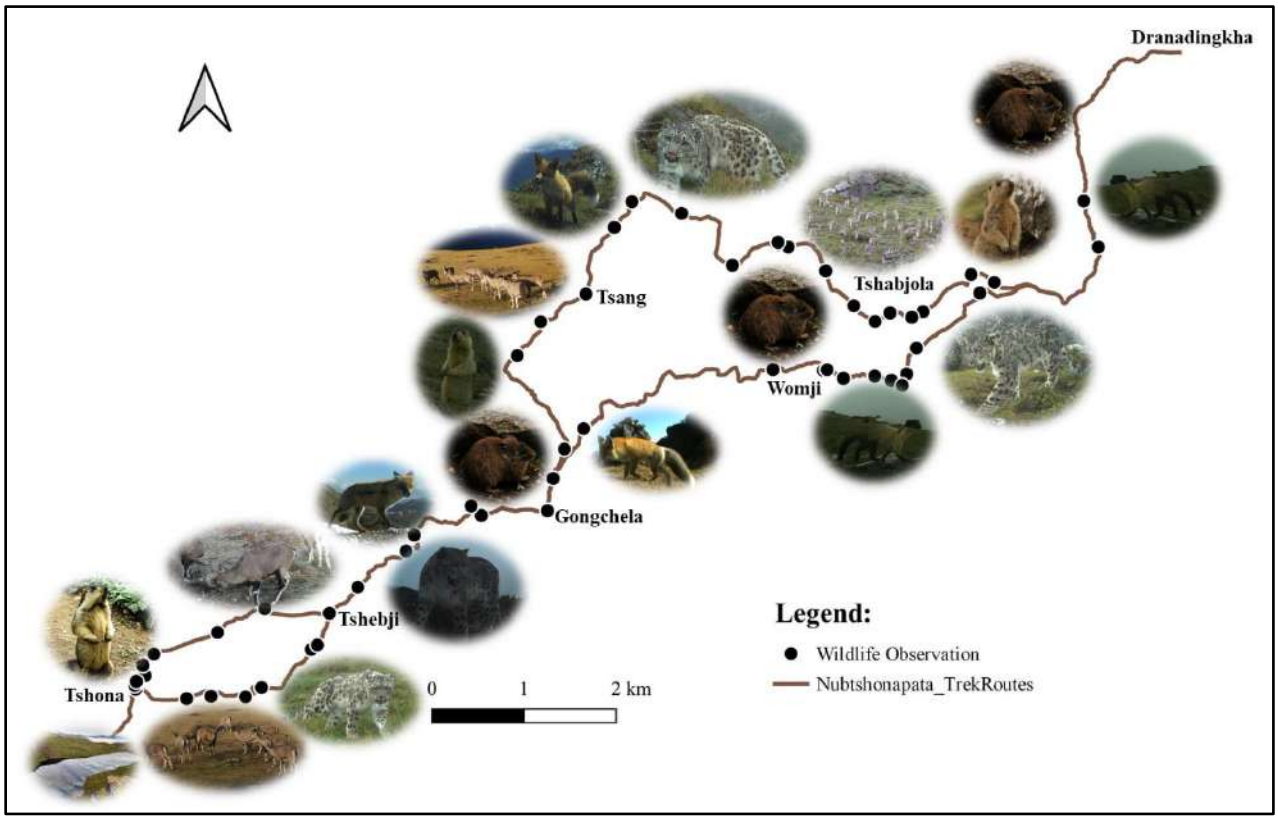

Figure 22: Mapping of wildlife along the Haa Dranadingkha-Nubtshonapata Trek

4. Conclusion

The study of flora and fauna species into species composition and abundance along the Haa Dranadingkha to Nubtshonapata Trek has yielded valuable insights into the biodiversity and ecological dynamics of this high-altitude environment. Employing a combination of field assessments and robust statistical estimations, this study has provided a comprehensive overview of rich composition of species richness, highlighting the diversity and distribution patterns along the trail.

The survey has also identified ecologically sensitivity areas that require careful management to ensure that tourism activities do not disrupt the habitats of vulnerable species like White poppy and Snow leopard, ensuring the sustainability of the ecosystem amidst increasing tourism. Furthermore, the findings affirm the region's potential for ecotourism, offering opportunities for wildlife enthusiasts, birdwatchers, and botanical researchers, while also promoting conservation efforts and local community engagement, ensuring minimal environmental impact.

The survey underscores the potential of the Haa Dranadingkha to Nubtshonapata Trek is positioned as a prime destination for nature-based ecotourism, with significant contributions to both conservation and local livelihoods.

However, the recommendations for ecotourism development include the creation of interpretive trails highlighting key species, training local guides, and adopting sustainable tourism practices, provide a clear path forward to balance tourism development with ecological preservation. This survey provides a solid foundation for promoting the Trek as a prime destination for nature-based ecotourism, fostering both environmental stewardship and economic growth.

We would like to extend our heartfelt gratitude to the colleagues of Jigme Khesar Strict Nature Reserve for their unwavering support and dedication throughout the survey. Your hard work and collaboration were essential to the successful completion of this study. We also wish to express our sincere appreciation to Helvetas-Bhutan and the Department of Tourism for initiating such an inspiring and impactful program. "It truly marks the promotion of nature-based ecotourism along the Haa Dranadingkha to Nubtshonapata Trek," creating opportunities for sustainable development while preserving the rich biodiversity of this remarkable region.

This survey would not have been possible without the collective effort and commitment of all involved.

Survey Team:

1. Ugyen Wangchuk, Chief Forestry Officer
2. Sangay Gyeltshen, Forest Ranger-I
3. Wangchuk, Forest Ranger-II
4. Kinzang Choeda, Asst. Forester
5. Pemba, Asst. Forester
6. Tashi, caretaker
7. Ugyen, Head, NCS/Focal

Annexure I: Plant record list along the trek

Sl/No.	Species	Family	Habit
1	*Abies densa*	Pinaceae	Conifer Tree
2	*Acanthocalyx nepalensis*	Morinaceae	Perennial Herb
3	*Acer campbellii*	Aceraceae	Deciduous Tree
4	*Acer* sp.	Aceraceae	Deciduous Tree
5	*Aconitum ferox*	Ranunculaceae	Annual Herb
6	*Aconogonon molle*	Polygonaceae	Annual Herb
7	*Ainsliaea aptera*	Asteraceae	Annual Herb
8	*Aletris pauciflora*	Melanthiceae	Annual Herb
9	*Allium* sp.	Alliaceae	Annual Herb
10	*Allium wallichii*	Alliaceae	Annual Herb
11	*Anaphalis busua*	Asteraceae	Perennial Herb
12	*Anaphalis contorta*	Asteraceae	Annual Herb
13	*Anaphilis cooperi*	Asteraceae	Annual Herb
14	*Anaphilis* sp.	Asteraceae	Annual Herb
15	*Andosace* sp.	Primulaceae	Annual Herb
16	*Anemone rivularies*	Ranunculaceae	Annual Herb
17	*Anemone obtusiloba*	Ranunculaceae	Annual Herb
18	*Anemone* sp.	Ranunculaceae	Annual Herb
19	*Angelica sikkimensis*	Apiaceae	Annual Herb
20	*Aorchis spathulata*	Orchidaceae	Orchid
21	*Arenaria debilis*	Caryophyllaceae	Annual Herb
22	*Arenaria* sp.	Caryophyllaceae	Annual Herb
23	*Arisaema* sp.	Araceae	Annual Herb
24	*Artemisia indica*	Asteraceae	Perennial Herb
25	*Aster albescens*	Asteraceae	Perennial Herb
26	*Aster diplostephioides*	Asteraceae	Perennial Herb
27	*Aster himalaicus*	Asteraceae	Perennial Herb
28	*Aster* sp.	Asteraceae	Perennial Herb
29	*Astragalus frigidus*	Leguminosae	Annual Herb
30	*Berberis aristata*	Berberidaceae	Evergreen shrub
31	*Berberis asiatica*	Berberidaceae	Evergreen shrub
32	*Bergenia purpurascens*	Saxifragaceae	Annual Herb
33	*Betula utilis*	Betulaceae	Deciduous Tree
34	*Bistorta affins*	Polygonaceae	Perennial Herb
35	*Bistorta macorphylla*	Polygonaceae	Perennial Herb
36	*Bistorta* sp.	Polygonaceae	Perennial Herb
37	*Bistorta vacciniifolia*	Polygonaceae	Perennial Herb
38	*Bistorta vivipara*	Polygonaceae	Perennial Herb
39	*Boschniakia himalaica*	Orobanchaceae	Perennial Herb

40	*Bryocarpum himalaicum*	Primulaceae	Annual Herb
41	*Buddleja colvilei*	Scrophulariaceae	Subshrub
42	*Bupleurum candollei*	Umbelliferae	Annual Herb
43	*Caltha palustris*	Ranunculaceae	Perennial Herb
44	*Campanula pallida*	Campanulaceae	Perennial Herb
45	*Cardamine macrophylla*	Cruciferae	Annual Herb
46	*Carex duthlei*	Cyperaceae	Perennial grass
47	*Carex haematostoma*	Cyperaceae	Perennial grass
48	*Carex* sp.	Cyperaceae	Perennial grass
49	*Cassiope fastigata*	Ericaceae	Subshrub
50	*Chusua pauciflora*	Orchidaceae	Orchid
51	*Cirsium eriophoroides*	Araliaceae	Perennial Herb
52	*Cirsium* sp.	Asteraceae	Perennial Herb
53	*Clematis montana*	Ranunculaceae	Climber
54	*Clintonia udensis*	Uvulariaceae	Perennial Herb
55	*Codonopsis foeteans*	Campanulaceae	Climbing Herb
56	*Cortiella hookeri*	Umbelliferae	Annual Herb
57	*Corydalis ecristata*	Fumariaceae	Annual Herb
58	*Corydalis juncea*	Fumariaceae	Annual Herb
59	*Corydalis crispa*	Fumariaceae	Annual Herb
60	*Cotoneaster microphyllus*	Rosaceae	Subshrub
61	*Cotoneaster frigidus*	Rosaceae	Subshrub
62	*Cremanthodium oblongtatum*	Asteraceae	Perennial Herb
63	*Cremanthodium palmatum*	Asteraceae	Perennial Herb
64	*Cremanthodium reniforme*	Asteraceae	Perennial Herb
65	*Cremanthodium* sp.	Asteraceae	Perennial Herb
66	*Cyananthus lobatus*	Campanulaceae	Perennial Herb
67	*Cyananthus* sp.	Campanulaceae	Perennial Herb
68	*Cynoglossum furcatum*	Boraginaceae	Annual Herb
69	*Cyperus* sp.	Cyperaceae	Grass
70	*Daphne bholua*	Thymelaeaceae	Evergreen shrub
71	*Delphinium cooperi*	Ranunculaceae	Perennial Herb
72	*Dipsacus inermos*	Dipsacaceae	Perennial Herb
73	*Dubyaea hispida*	Asteraceae	Perennial Herb
74	*Epilobium wallichianum*	Onagraceae	Annual Herb
75	*Eriophyton wallichii*	Labiatae	Perennial Herb
76	*Elsholtzia fruticosa*	Lamiaceae	Subshrub
77	*Euphorbia griffithii*	Euphorbiaceae	Perennial Herb
78	*Euphrasia melanosticta*	Scrophulariaceae	Annual Herb
79	*Fagopyrum esculentum*	Polygonaceae	Annual Herb
80	*Fragaria nubicola*	Rosaceae	Annual Herb
81	*Fritillaria cirrhosa*	Liliaceae	Annual Herb

82	*Fritillaria delavayi*	Liliaceae	Annual Herb
83	*Gagea flavonutans*	Liliaceae	Perennial Herb
84	*Gaillardia spathulata*	Asteraceae	Annual Herb
85	*Galeopsis bifida*	Lamiaceae	Annual Herb
86	*Gaultheria* sp.	Ericaceae	Subshrub
87	*Gaultheria trichophylla*	Ericaceae	Subshrub
88	*Gentiana capitata*	Gentianaceae	Annual Herb
89	*Gentiana elwesii*	Gentianaceae	Annual Herb
90	*Gentiana* sp.	Gentianaceae	Annual Herb
91	*Gentiana tibetica*	Gentianaceae	Annual Herb
92	*Geranium donianum*	Geraniaceae	Annual Herb
93	*Geranium refractum*	Geraniaceae	Annual Herb
94	*Geranium* sp.	Geraniaceae	Annual Herb
95	*Geum elatum*	Rosaceae	Perennial Herb
96	*Goodyera* sp.	Orchidaceae	Orchid
97	*Gueldenstaedtia himalaica*	Fabaceae	Perennial Herb
98	*Gymnadenia orchidis*	Orchidaceae	Orchid
99	*Gypsophila cerastioides*	Caryophyllaceae	Perennial Herb
100	*Hackelia uncinata*	Boraginaceae	Perennial Herb
101	*Halenia elliptica*	Gentianaceae	Biennial herb
102	*Hemiphragma heterophylum*	Scrophulariaceae	Perennial Herb
103	*Heracleum obtusifolium*	Umbelliferae	Perennial Herb
104	*Heracleum nepalense*	Umbelliferae	Perennial Herb
105	*Heracleum sphondylium*	Umbelliferae	Perennial Herb
106	*Hermanium* sp.	Orchidaceae	Orchid
107	*Herminium josephi*	Orchidaceae	Orchid
108	*Hydrangea heteromalla*	Hydrangeaceae	Subshrub
109	*Hypericum choisianum*	Hypericaea	Subshrub
110	*Impatiens* sp.	Balsaminaceae	Annual Herb
111	*Impatiens glandulifera*	Balsaminaceae	Annual Herb
112	*Impatiens urticifolia*	Balsaminaceae	Annual Herb
113	*Inula hookeri*	Asteraceae	Perennial Herb
114	*Inula* sp.	Asteraceae	Perennial Herb
115	*Iris clarkei*	Iridaceae	Annual Herb
116	*Juncus* sp.	Juncaceae	Annual Herb
117	*Juncus thomsonii*	Juncaceae	Annual Herb
118	*Juniperus recurva*	Cupressaceae	Conifer Tree
119	*Juniperus squamata*	Cupressaceae	Conifer Shrub
120	*Koenigia forrestii*	Polygonaceae	Perennial Herb
121	*Koengia mollis*	Polygonaceae	Perennial Herb
122	*Lagotis kunawurensis*	Scrophulariaceae	Perennial Herb
123	*Larix griffithiana*	Pinaceae	Conifer Tree

124	*Leontopodium himalayanum*	Asteraceae	Perennial Herb
125	*Leptodermis oblonga*	Rubiaceae	Subshrub
126	*Ligularia amplexicaulis*	Asteraceae	Perennial Herb
127	*Ligularia atkinsonii*	Asteraceae	Perennial Herb
128	*Ligularia hookeri*	Asteraceae	Perennial Herb
129	*Ligularia mortonii*	Asteraceae	Perennial Herb
130	*Ligularia* sp.	Asteraceae	Perennial Herb
131	*Ligularia virgaurea*	Asteraceae	Perennial Herb
132	*Lonicera* sp.	Caprifoliaceae	Evergreen shrub
133	*Maianthemum purpureum*	Convallariaceae	Perennial Herb
134	*Meconopsis elongata*	Papaveraceae	Perennial Herb
135	*Meconopsis paniculata*	Papaveraceae	Perennial Herb
136	*Meconopsis simplicifolia*	Papaveraceae	Perennial Herb
137	*Meconopsis superba*	Papaveraceae	Perennial Herb
138	*Megacodon stylophorus*	Gentianaceae	Annual Herb
139	*Morina longifolia*	Caprifoliaceae	Perennial Herb
140	*Morina polyphylla*	Caprifoliaceae	Perennial Herb
141	*Nardostachys jatamansi*	Valerianaceae	Perennial Herb
142	*Neopicrorhiza scrophulariiflora*	Scrophulariaceae	Perennial Herb
143	*Neottianthe cucullata*	Orchidaceae	Orchid
144	*Nepeta* sp.	Labiatae	Annual Herb
145	*Notholirion macrophyllum*	Liliaceae	Perennial Herb
146	*Nepeta lamiopsis*	Labiatae	Annual Herb
147	*Odontostemma glandulosa*	Caryophyllaceae	Perennial Herb
148	*Onychium cryptogrammoides*	Pteridaceae	Fern
149	*Ophiopogon bondinieri*	Convallariaceae	Perennial Herb
150	*Ophiopogon* sp.	Convallariaceae	Perennial Herb
151	*Osmunda cinnamomea*	Osmundaceae	Fern
152	*Oxalis acetosella*	Oxalidaceae	Perennial Herb
153	*Oxalis* sp.	Oxalidaceae	Perennial Herb
154	*Oxygraphis polypetala*	Ranunculaceae	Perennial Herb
155	*Parasenecio palmatisectus*	Asteraceae	Perennial Herb
156	*Parnassia chinensis*	Parnassiaceae	Perennial Herb
157	*Parnassia delavayi*	Parnassiaceae	Perennial Herb
158	*Parnassia* sp.	Parnassiaceae	Perennial Herb
159	*Pedicularis diffusa*	Orobanchaceae	Perennial Herb
160	*Pedicularis longiflora*	Orobanchaceae	Perennial Herb
161	*Pedicularis megalantha*	Orobanchaceae	Perennial Herb
162	*Pedicularis prainiana*	Orobanchaceae	Perennial Herb
163	*Pedicularis siphonantha*	Orobanchaceae	Perennial Herb
164	*Pedicularis* sp.	Orobanchaceae	Perennial Herb
165	*Pegaeophyton scapiflorum*	Brassicaceae	Annual Herb

166	*Persicaria reticulata*	Polygonaceae	Annual Herb
167	*Persicaria* sp.	Polygonaceae	Annual Herb
168	*Phlomis rotata*	Lamiaceae	Perennial Herb
169	*Phlomis* sp.	Lamiaceae	Perennial Herb
170	*Phlomis tibetica*	Lamiaceae	Perennial Herb
171	*Picea spinolasa*	Pinaceae	Conifer Tree
172	*Pieris formosa*	Pieridae	Subshrub
173	*Pinus wallichiana*	Pinaceae	Conifer Tree
174	*Piptanthus nepalensis*	Leguminosae	Annual Herb
175	*Plantago erosa*	Plantaginaceae	Perennial Herb
176	*Platanthera* sp.	Orchidaceae	Orchid
177	*Polygonatum cirrhifolium*	Asparagaceae	Annual Herb
178	*Polygonatum* sp.	Asparagaceae	Annual Herb
179	*Potentilla arbuscula*	Rosaceae	Deciduous Shrub
180	*Potentilla coriandrifolia*	Rosaceae	Perennial Herb
181	*Potentilla cuneata*	Rosaceae	Perennial Herb
182	*Potentilla peduncularis*	Rosaceae	Perennial Herb
183	*Potentilla* sp.	Rosaceae	Perennial Herb
184	*Poterium filiforme*	Rosaceae	Perennial Herb
185	*Primula calderiana*	Primulaceae	Annual Herb
186	*Primula capitata*	Primulaceae	Annual Herb
187	*Primula denticulata*	Primulaceae	Annual Herb
188	*Primula elonggata*	Primulaceae	Annual Herb
189	*Primula gracilipes*	Primulaceae	Annual Herb
190	*Primula griffithii*	Primulaceae	Annual Herb
191	*Primula kingii*	Primulaceae	Annual Herb
192	*Primula longiflora*	Primulaceae	Annual Herb
193	*Primula munroi*	Primulaceae	Annual Herb
194	*Primula primulina*	Primulaceae	Annual Herb
195	*Primula sikkimensis*	Primulaceae	Annual Herb
196	*Primula smithiana*	Primulaceae	Annual Herb
197	*Primula* sp.	Primulaceae	Perennial Herb
198	*Primula uniflora*	Primulaceae	Perennial Herb
199	*Panax pseudo-ginseng*	Araliaceae	Annual Herb
200	*Pteracanthus alatus*	Acanthaceae	Perennial Herb
201	*Pteridium revolutum*	Dennstaedtiaceae	Fern
202	*Quercus semecarpifolia*	Fagaceae	Evergreen Tree
203	*Ranunculus diffusus*	Ranunculaceae	Annual Herb
204	*Rheum australe*	Polygonaceae	Annual Herb
205	*Rheum noble*	Polygonaceae	Annual Herb
206	*Rhodiola bupleuroides*	Crassulaceae	Perennial Herb
207	*Rhodiola crenulata*	Crassulaceae	Perennial Herb

208	*Rhodiola* sp.	Crassulaceae	Perennial Herb
209	*Rhododendron aeruginosum*	Ericaceae	Subshrub
210	*Rhododendron anthopogon*	Ericaceae	Subshrub
211	*Rhododendron arboreum*	Ericaceae	Evergreen shrub
212	*Rhododendron campanulatum*	Ericaceae	Evergreen shrub
213	*Rhododendron cinnabarinum*	Ericaceae	Evergreen shrub
214	*Rhododendron hodgsonii*	Ericaceae	Evergreen Tree
215	*Rhododendron lanatum*	Ericaceae	Evergreen shrub
216	*Rhododendron lepidotum*	Ericaceae	Subshrub
217	*Rhododendron setosum*	Ericaceae	Subshrub
218	*Rhododendron thomsonii*	Ericaceae	Evergreen shrub
219	*Rhododendron wallichii*	Ericaceae	Evergreen shrub
220	*Rhododendron wightii*	Ericaceae	Evergreen shrub
221	*Ribes griffithii*	Grossulariaceae	Deciduous shrub
222	*Ribes* sp.	Grossulariaceae	Deciduous shrub
223	*Rosa macrophylla*	Rosaceae	Deciduous shrub
224	*Rosa sericea*	Rosaceae	Deciduous shrub
225	*Roscoea alpina*	Zingiberaceae	Annual Herb
226	*Rubus ellipticus*	Rosaceae	Subshrub
227	*Rubus* sp.	Rosaceae	Subshrub
228	*Rumex nepalensis*	Polygonaceae	Perennial Herb
229	*Salix flabellaris*	Salicaceae	Deciduous shrub
230	*Salix sikkimensis*	Salicaceae	Deciduous shrub
231	*Salix tetragonum*	Salicaceae	Deciduous Tree
232	*Salvia campanulata*	Lamiaceae	Perennial Herb
233	*Salvia* sp.	Lamiaceae	Perennial Herb
234	*Sambucus sp. adnata*	Adoxaceae	Subshrub
235	*Satyrium nepalense*	Orchidaceae	Orchid
236	*Saussurea gossypiphora*	Asteraceae	Perennial Herb
237	*Saussurea przewalskii*	Asteraceae	Perennial Herb
238	*Saussurea nepalensis*	Asteraceae	Perennial Herb
239	*Saxifraga brachypoda*	Saxifragaceae	Annual Herb
240	*Saxifraga hispidula*	Saxifragaceae	Annual Herb
241	*Saxifraga* sp.	Saxifragaceae	Annual Herb
242	*Schisandra grandiflora*	Schisandraceae	Deciduous shrub
243	*Sedum* sp.	Crassulaceae	Annual Herb
244	*Sedum trullipetalum*	Crassulaceae	Annual Herb
245	*Selinum* sp.	Apiaceae	Annual Herb
246	*Selinum wallichianum*	Apiaceae	Annual Herb
247	*Senecio diversifolius*	Asteraceae	Perennial Herb
248	*Senecio laetus*	Asteraceae	Perennial Herb
249	*Senecio* sp.	Asteraceae	Perennial Herb

250	*Setaria* sp.	Poaceae	Grass
251	*Silene edgeworthii*	Caryophyllaceae	Perennial Herb
252	*Silene birgittae*	Caryophyllaceae	Perennial Herb
253	*Smilax* sp.	Smilacaceae	Climber
254	*Solitaria ludlowii*	Polygonaceae	Perennial Herb
255	*Sorbus microphylla*	Rosaceae	Evergreen shrub
256	*Sorbus* sp.	Rosaceae	Evergreen shrub
257	*Soroseris hookeriana*	Asteraceae	Perennial Herb
258	*Spiraea arcuata*	Rosaceae	Deciduous shrub
259	*Spiraea canescens*	Rosaceae	Deciduous shrub
260	*Spiraea* sp.	Rosaceae	Deciduous shrub
261	*Spongiocarpella purpurea*	Fabaceae	Perennial Herb
262	*Stellaria* sp.	Caryophyllaceae	Annual Herb
263	*Streptopus simplex*	Liliaceae	Perennial Herb
264	*Swertia hookeri*	Gentianaceae	Perennial Herb
265	*Synotis coopari*	Asteraceae	Perennial Herb
266	*Synotis wallichii*	Asteraceae	Perennial Herb
267	*Tanacetum atkinsonii*	Asteraceae	Perennial Herb
268	*Taraxacum eriopodum*	Asteraceae	Perennial Herb
269	*Taraxacum sp.*	Asteraceae	Perennial Herb
270	*Tetrataenium nepalense*	Apiaceae	Perennial Herb
271	*Thalictrum* sp.	Ranunculaceae	Annual Herb
272	*Thalictrum chelidonii*	Ranunculaceae	Annual Herb
273	*Thalictrum elegans*	Ranunculaceae	Annual Herb
274	*Tsuga dumosa*	Pinaceae	Conifer Tree
275	*Valeriana hardwickei*	Caprifoliaceae	Perennial Herb
276	*Valeriana* sp.	Caprifoliaceae	Perennial Herb
277	*Veronica ciliata*	Scrophulariaceae	Perennial Herb
278	*Veronica himalensis*	Scrophulariaceae	Perennial Herb
279	*Veronica* sp.	Scrophulariaceae	Perennial Herb
280	*Viola biflora*	iolaceae	Annual Herb
281	*Viola* sp.	Violaceae	Annual Herb
282	*Yushania microphylla*	Poaceae	Bamboo

Annexure II: Bird record list along the trek

List	Mc. List	Species	Altitude	Latitude	Longitude	Habitat
1	5	Greenish Warbler	3285	27.39429	89.25205	MC
1	4	Blue Whistling Thrush	3278	27.39429	89.25210	MC
1	3	Oriental Turtle Dove	3278	27.39428	89.25216	MC
1	2	Large-billed Crow	3278	27.39431	89.25233	MC
1	1	Russet Sparrow	3278	27.39432	89.25240	MC
2	5	Spotted Laughingthrush	3295	27.39420	89.24985	MC
2	4	Grey Bushchat	3293	27.39434	89.25004	MC
2	3	Rufous-gorgeted Flycatcher	3282	27.39429	89.25112	MC
2	2	Greenish Warbler	3786	27.39433	89.25148	MC
2	1	Yellow-billed Blue Magpie	3786	27.39434	89.25169	MC
3	5	White-browed Bush Robin	3380	27.39210	89.24536	MC
3	4	Oriental Turtle Dove	3324	27.39353	89.24828	MC
3	3	Spotted Nutcracker	3306	27.39356	89.24909	MC
3	2	White-collared Blackbird	3303	27.39373	89.24934	MC
3	1	Hill Pratridge	3302	27.39373	89.24934	MC
4	5	Himalayan blue tail	3477	27.38895	89.24243	MC
4	4	Spotted Laughingthrush	3411	27.39018	89.24400	MC
4	3	Hill Partridge	3383	27.39162	89.24510	MC
4	2	Spotted Nutcracker	3383	27.39163	89.24509	MC
4	1	Greenish Warbler	3382	27.39174	89.24525	MC
5	5	Large-billed Crow	3517	27.38766	89.24179	Fir forest
5	4	Hill Partridge	3517	27.38778	89.24178	Fir forest
5	3	Spotted Laughingthrush	3511	27.38799	89.24170	Fir forest
5	2	White-throated Laughingthrush	3521	27.38805	89.24175	Fir forest
5	1	Tickell's Leaf Warbler	3490	27.38901	89.24244	Fir forest
6	5	White-browed Bush Robin	3602	27.38138	89.24204	Fir forest
6	4	White-throated Laughingthrush	3602	27.38210	89.24189	Fir forest
6	3	Darjeeling Woodpecker	3601	27.38210	89.24189	Fir forest
6	2	Collared Grosbeak	3601	27.38210	89.24189	Fir forest
6	1	Spotted Nutcracker	3591	27.38217	89.24198	Fir forest
7	5	Spotted Nutcracker	3724	27.37818	89.24318	Fir forest
7	4	Collared Grosbeak	3680	27.37964	89.24282	Fir forest
7	3	Greenish warbler	3685	27.37969	89.24281	Fir forest
7	2	Blood Pheasant	3670	27.38010	89.24281	Fir forest
7	1	Himalayan Bluetail	3664	27.38031	89.24271	Fir forest
8	5	Blood Pheasant	3805	27.37589	89.24400	Fir forest
8	4	White-browed Bush Robin	3805	27.37597	89.24396	Fir forest
8	3	Yellow-billed Blue Magpie	3788	27.37664	89.24378	Fir forest
8	2	Greenish Warbler	3788	27.37661	89.24383	Fir forest
8	1	Rufous-gorgeted Flycatcher	3762	27.37717	89.24363	Fir forest
9	5	Greenish Warbler	3893	27.37311	89.24395	Fir forest
9	4	Coal Tit	3892	27.37318	89.24408	Fir forest
9	3	Scaley-breasted Wren Babbler	3864	27.37476	89.24447	Fir forest
9	2	Large-billed Crow	3868	27.37505	89.24444	Fir forest

9	1	Black-faced Laughingthrush	3868	27.37505	89.24444	Fir forest
10	5	Chestnut-crowned Laughingthrush	3908	27.37144	89.24291	Juniper
10	4	Greenish Warbler	3908	27.37144	89.24291	Juniper
10	3	Blue-fronted Redstart	3906	27.37240	89.24362	Juniper
10	2	White-winged Grosbeak	3906	27.37240	89.24362	Juniper
10	1	White-collared Blackbird	3905	27.37240	89.24362	juniper
11	5	Blue-fronted Redstart	3930	27.37060	89.24195	Alpine
11	4	Greenish Warbler	3915	27.37096	89.24289	Alpine
11	3	Spotted Nutcracker	3915	27.37104	89.24290	Alpine
11	2	Coal Tit	3915	27.37104	89.24290	Alpine
11	1	Rosy Pipit	3915	27.37104	89.24289	Alpine
12	5	Olive-backed Pipit	3971	27.37138	89.23577	Alpine
12	4	Greenish Warbler	3949	27.37082	89.23865	Aline
12	3	White-browed Rosefinch	3948	27.37070	89.23954	Alpine
12	2	Spotted Nutcracker	3945	27.37052	89.24006	Alpine
12	1	White-collared Blackbird	3945	27.37041	89.24025	Alpine
13	5	Plain Mountain Finch	4100	27.37081	89.22772	Alpine
13	4	Spotted Nutcracker	4100	27.37080	89.22771	Alpine
13	3	Olive-backed Pipit	4075	27.37166	89.22956	Alpine
13	2	Blue-fronted Redstart	4009	27.37258	89.23145	Alpine
13	1	White-browed Rosefinch	3997	27.37131	89.23348	Alpine
14	5	Red-billed Chough	4138	27.36777	89.22007	Alpine
14	4	Spotted Nutcracker	4120	27.36824	89.22406	Alpine
14	3	Olive-backed Pipit	4108	27.36951	89.22643	Alpine
14	2	Blue-fronted Redstart	4107	27.36967	89.22664	Alpine
14	1	White-browed Rosefinch	4106	27.36977	89.22674	Alpine
15	5	Black-faced Laughingthrush	4146	27.37535	89.20857	Alpine
15	4	Red-billed Chough	4136	27.37482	89.21323	Alpine
15	3	Blue-fronted Redstart	4135	27.37483	89.21326	Alpine
15	2	Olive-backed pipit	4150	27.37017	89.21677	Alpine
15	1	Collared Grosbeak	4145	27.36875	89.21818	Alpine
16	5	Solitary Snipe	4146	27.37364	89.20330	Alpine
16	4	Blue-fronted Redstart	4148	27.37314	89.20423	Alpine
16	3	Plain Mountain Finch	4147	27.37310	89.20463	Alpine
16	2	Himalayan Monal	4136	27.37485	89.20639	Alpine
16	1	Greenish Warbler	4136	27.37485	89.20639	Alpine
17	5	Red-billed Chough	4115	27.37783	89.19978	Alpine
17	4	White-browed Ros finch	4112	27.37777	89.20221	Alpine
17	3	White-collared Blackbird	4114	27.37751	89.20272	Alpine
17	2	Collared Grosbeak	4142	27.37445	89.20240	Alpine
17	1	Collared Grosbeak	4148	27.37371	89.20315	Alpine
18	5	Golden Bush Robin	4138	27.37954	89.19356	Alpine
18	4	Black-faced Laughingthrush	4132	27.37994	89.19464	Alpine
18	3	Olive-backed Pipit	4134	27.37872	89.19755	Alpine
18	2	White-browed Rosefinch	4130	27.37822	89.19849	Alpine
18	1	White-collared Blackbird	4115	27.37788	89.19964	Alpine
19	5	Red-billed Chough	4213	27.37632	89.19087	Alpine
19	4	Blue-fronted Redstart	4213	27.37644	89.19106	Alpine

19	3	Olive-backed Pipit	4190	27.37791	89.19243	Alpine
19	2	Collared Grosbeak	4182	27.37810	89.19267	Alpine
19	1	Golden Bush Robin	4166	27.37813	89.19269	Alpine
20	5	Grey-backed shrike	4048	27.36685	89.18394	Alpine
20	4	Spotted nutcracker	4208	27.37016	89.18823	Alpine
20	3	Olive-backed Pipit	4208	27.37016	89.18823	Alpine
20	2	Blue-fronted Redstart	4221	27.37319	89.18847	Alpine
20	1	White-browed Rosefinch	4217	27.37480	89.18927	Alpine
21	5	White-browed Rosefinch	4053	27.36514	89.18141	Alpine
21	4	Blue-fronted Redstart	4095	27.36530	89.18188	Alpine
21	3	Common green shank	4043	27.36617	89.18246	Alpine
21	2	Large-billed Crow	4056	27.36651	89.18306	Alpine
21	1	White-throated Dipper	4054	27.36653	89.18313	Alpine
22	5	Greenish Warbler	4091	27.36266	89.17949	Alpine
22	4	Olive-backed Pipit	4105	27.36416	89.18057	Alpine
22	3	White-collared blackbird	4087	27.36421	89.18063	Alpine
22	2	Common Greenshank	4054	27.36442	89.18077	Alpine
22	1	White-throated Dipper	4053	27.36442	89.18077	Alpine
23	5	Asian House Martin	4129	27.35816	89.18467	Alpine
23	4	Red-billed Chough	4145	27.36025	89.18265	Alpine
23	3	Black-faced laughingthrush	4133	27.36024	89.18265	Alpine
23	2	Olive-backed Pipit	4105	27.36076	89.18238	Alpine
23	1	White-browed Bush Robin	4101	27.36268	89.17958	Alpine
24	5	Greenish Warbler	4099	27.35293	89.18481	Alpine
24	4	Golden Bush Robin	4109	27.35326	89.18513	Alpine
24	3	Blue-fronted Redstart	4109	27.35326	89.18513	Alpine
24	2	Greenish Warbler	4099	27.35664	89.18564	Alpine
24	1	White-browed Rosefinch	4091	27.35727	89.18524	Alpine
25	5	Olive-backed Pipit	4131	27.34872	89.17637	Alpine
25	4	Himalayan Monal	4161	27.34918	89.18129	Alpine
25	3	Black-faced Laughingthrush	4168	27.35024	89.18422	Alpine
25	2	White-browed Bush Robin	4156	27.35080	89.18425	Alpine
25	1	White-browed Rosefinch	4153	27.35111	89.18436	Alpine
26	5	Golden Bush Robin	4033	27.34704	89.16975	Alpine
26	4	Greenish Warbler	4011	27.34825	89.17073	Alpine
26	3	Chestnut-crowned Laughingthrush	4021	27.34834	89.17115	Alpine
26	2	White-browed Rosefinch	4091	27.34774	89.17406	Alpine
26	1	Red-billed Chough	4109	27.34808	89.17461	Alpine
27	5	Blue-fronted Redstart	4155	27.34439	89.16781	Alpine
27	4	Black-faced Laughingthrush	4155	27.34439	89.16781	Alpine
27	3	White-browed Rosefinch	4118	27.34525	89.16903	Alpine
27	2	Greenish Warbler	4050	27.34655	89.16951	Alpine
27	1	White-browed Bush Robin	4050	27.34654	89.16947	Alpine
28	5	Rosy Pipit	4226	27.34126	89.16315	Alpine
28	4	Plain Mountain Finch	4204	27.34244	89.16463	Alpine
28	3	Himalayan Monal	4189	27.34330	89.16512	Alpine
28	2	Greenish Warbler	4178	27.34352	89.16544	Alpine
28	1	Red-billed Chough	4174	27.34368	89.16601	Alpine

29	5	Tibetan Snowcock	4304	27.33880	89.16005	Alpine
29	4	Olive-backed Pipit	4262	27.33991	89.16187	Alpine
29	3	White-browed Rosefinch	4250	27.34022	89.16220	Alpine
29	2	Rufous-breasted Accentor	4239	27.34088	89.16292	Alpine
29	1	Alpine Thrush	4241	27.34111	89.16308	Alpine
30	5	White-browed Bush Robin	4152	27.33841	89.15014	Alpine
30	4	Black-faced Laughingthrush	4202	27.33860	89.15506	Alpine
30	3	Greenish Warbler	4202	27.33859	89.15507	Alpine
30	2	White-browed Rosefinch	4205	27.33873	89.15545	Alpine
30	1	Rosy Pipit	4259	27.33868	89.15791	Alpine
31	5	Rosy Pipit	4216	27.33311	89.13917	Alpine
31	4	Red-billed Chough	4234	27.33367	89.13980	Alpine
31	3	Greenish Warbler	4248	27.33570	89.14403	Alpine
31	2	Golden Bush Robin	4237	27.33661	89.14699	Alpine
31	1	White-browed Rosefinch	4206	27.33754	89.14848	Alpine
32	5	Black-faced Laughingthrush	4176	27.33179	89.13898	Alpine
32	4	Olive-backed Pipit	4176	27.33186	89.13906	Alpine
32	3	White-browed Rosefinch	4176	27.33207	89.13908	Alpine
32	2	Rosy Pipit	4193	27.33234	89.13895	Alpine
32	1	Alpine Thrush	4207	27.33280	89.13888	Alpine
33	5	Blue-fronted Restart	4212	27.33017	89.14235	Alpine
33	4	Rufous-breasted Accentor	4212	27.33027	89.14188	Alpine
33	3	White-browed Rosefinch	4185	27.33040	89.14077	Alpine
33	2	Black-faced Laughingthrush	4185	27.33041	89.14066	Alpine
33	1	Rosy Pipit	4173	27.33133	89.13950	Alpine
34	5	White-browed Rosefinch	4312	27.33026	89.15079	Alpine
34	4	Alpine Thrush	4298	27.33019	89.14999	Alpine
34	3	Rosy Pipit	4243	27.33082	89.14681	Alpine
34	2	Olive-backed Pipit	4235	27.33077	89.14588	Alpine
34	1	Red-billed Chough	4213	27.33049	89.14478	Alpine
35	5	Blacked-faced laughingthrush	4403	27.33145	89.15353	Alpine
35	4	Snow Partridge	4393	27.33157	89.15311	Alpine
35	3	Golden Rush Robin	4371	27.33164	89.15196	Alpine
35	2	White-browed Rosefinch	4349	27.33092	89.15193	Alpine
35	1	Rosy Pipit	4344	27.33087	89.15178	Alpine
36	5	Rufous-breasted Accentor	4306	27.33855	89.16039	Alpine
36	4	Plain Mountain Finch	4346	27.33579	89.15884	Alpine
36	3	Tibetan Snowcock	4335	27.33453	89.15751	Alpine
36	2	Alpine Accentor	4361	27.33403	89.15680	Alpine
36	1	Olive-backed Pipit	4370	27.33352	89.15630	Alpine
37	5	Spotted Nutcracker	3946	27.35764	89.18879	Fir forest
37	4	Coal Tit	3978	27.35726	89.18818	Fir forest
37	3	Eurasian Treecreeper	3982	27.35712	89.18806	Fir forest
37	2	Greenish Warbler	3983	27.35706	89.18783	Fir forest
37	1	White-browed Rosefinch	4054	27.35567	89.18750	Alpine
38	5	White-browed Bush Robin	3717	27.36060	89.19587	Fir forest
38	4	Greenish Warbler	3724	27.36034	89.19476	Fir forest
38	3	Darjeeling Woodpecker	3901	27.35891	89.19003	Fir forest

38	2	Blood Pheasant	3903	27.35827	89.19006	Fir forest
38	1	Golden Bush Robin	3930	27.35810	89.18947	Fir forest
39	5	Greenish Warbler	3715	27.36050	89.19587	Fir forest
39	4	Eurasian Treecreeper	3710	27.36077	89.19588	Fir forest
39	3	Olive-backed Pipit	3712	27.36072	89.19595	Fir forest
39	2	White-winged Grosbeak	3710	27.36072	89.19595	Fir forest
39	1	Blanford's Rosefinch	3710	27.36070	89.19596	Fir forest
40	5	Gold-naped Finch	3718	27.36226	89.19983	Fir forest
40	4	Blue-fronted Redstart	3718	27.36226	89.19983	Fir forest
40	3	Buff-barred Warbler	3710	27.36231	89.19943	Fir forest
40	2	Greenish Warbler	3746	27.36091	89.19628	Fir forest
40	1	White-winged Grosbeak	3746	27.36089	89.19628	Fir forest
41	5	Rufous-gorgeted Flycatcher	3733	27.36250	89.20368	Fir forest
41	4	Black-faced Laughingthrush	3738	27.36257	89.20279	Fir forest
41	3	White-browed Bush Robin	3715	27.36300	89.20172	Fir forest
41	2	Greenish Warbler	3736	27.36310	89.20145	Fir forest
41	1	White-winged Grosbeak	3714	27.36270	89.20083	Fir forest
42	5	Spotted Nutcracker	3821	27.36242	89.20700	Fir forest
42	4	Collared Grosbeak	3821	27.36242	89.20700	Fir forest
42	3	White-winged Grosbeak	3747	27.36252	89.20369	Fir forest
42	2	Lemon-rumped Warbler	3747	27.36252	89.20369	Fir forest
42	1	Buff-barred Warbler	3747	27.36252	89.20369	Fir forest
43	5	White-browed Rosefinch	3999	27.36383	89.21354	Alpine
43	4	Coal Tit	3925	27.36302	89.21073	Fir forest
43	3	White-winged Grosbeak	3901	27.36290	89.20994	Fir forest
43	2	White-collared Blackbird	3884	27.36316	89.20953	Fir forest
43	1	Greenish Warbler	3879	27.36315	89.20905	Fir forest
44	5	White-collared Blackbird	4080	27.36273	89.21561	Alpine
44	4	Greenish Warbler	4043	27.36282	89.21541	Alpine
44	3	Red-billed Chough	4039	27.36305	89.21460	Alpine
44	2	Olive-backed Pipit	4027	27.36296	89.21434	Alpine
44	1	Large-billed Crow	4000	27.36353	89.21400	Alpine
45	5	White-browed Rosefinch	4056	27.36247	89.21960	Alpine
45	4	Plain Mountain Finch	4054	27.36250	89.21954	Alpine
45	3	Olive-backed Pipit	4085	27.36249	89.21794	Alpine
45	2	Spotted Nutcracker	4085	27.36250	89.21792	Alpine
45	1	Greenish Warbler	4085	27.36250	89.21792	Alpine
46	5	Black-faced Laughingthrush	4042	27.36624	89.22604	Alpine
46	4	Red-billed Chough	4089	27.36442	89.22296	Alpine
46	3	Rosy Pipit	4099	27.36201	89.22184	Alpine
46	2	White-browed Rosefinch	4090	27.36227	89.22087	Alpine
46	1	Blue-fronted Redstart	4084	27.36237	89.22009	Alpine
47	5	White-browed Rosefinch	3948	27.37137	89.23715	Juniper
47	4	Blue-fronted Redstart	3944	27.37065	89.23469	Juniper
47	3	Rosy Pipit	3943	27.37048	89.23377	Juniper
47	2	Plain Mountain Finch	3943	27.37048	89.23377	Juniper
47	1	Golden Bush Robin	3934	27.37102	89.23180	Juniper

Annexure III: Mammal record list along the trek

Name	Evidence	Sign	Latitude	Longitude	Altitude
Pika	Direct Sighting		27.370651	89.231464	3944
Himalayan marmot	Direct Sighting		27.365963	89.222786	4059
Red fox	Indirect sighting	Dropping/Scats	27.362030	89.221807	4099
Snow leopard	Indirect sighting	Dropping/Scats	27.362969	89.214346	4027
Pika	Direct Sighting		27.363017	89.208784	3867
Snow leopard	Indirect sighting	Dropping/Scats	27.357164	89.188073	4013
Snow leopard	Indirect sighting	Dropping/Scats	27.357138	89.188028	4012
Snow leopard	Indirect sighting	Dropping/Scats	27.335332	89.158263	4355
Blue sheep	Direct Sighting		27.330677	89.147304	4296
Blue sheep	Indirect sighting	Dropping/Scats	27.371701	89.233052	4013
Blue sheep	Indirect sighting	Dropping/Scats	27.365224	89.224527	4059
Blue sheep	Indirect sighting	Dropping/Scats	27.368789	89.225235	4129
Blue sheep	Indirect sighting	Dropping/Scats	27.368644	89.221608	4138
Blue sheep	Indirect sighting	Dropping/Scats	27.367805	89.219962	4146
Blue sheep	Indirect sighting	Dropping/Scats	27.362672	89.223470	4107
Blue sheep	Indirect sighting	Dropping/Scats	27.361571	89.222998	4123
Blue sheep	Indirect sighting	Dropping/Scats	27.362462	89.219962	4102
Blue sheep	Indirect sighting	Dropping/Scats	27.362213	89.216531	4076
Blue sheep	Indirect sighting	Dropping/Scats	27.363042	89.214729	4047
Blue sheep	Indirect sighting	Dropping/Scats	27.369317	89.217622	4161
Blue sheep	Indirect sighting	Dropping/Scats	27.372721	89.214514	4162
Blue sheep	Indirect sighting	Dropping/Scats	27.375048	89.210378	4162
Blue sheep	Indirect sighting	Dropping/Scats	27.373218	89.204263	4155
Blue sheep	Indirect sighting	Dropping/Scats	27.378265	89.198638	4142
Blue sheep	Indirect sighting	Dropping/Scats	27.376843	89.191254	4227
Blue sheep	Indirect sighting	Dropping/Scats	27.370306	89.188191	4212
Blue sheep	Indirect sighting	Dropping/Scats	27.367567	89.183252	4115
Blue sheep	Indirect sighting	Dropping/Scats	27.355108	89.185942	4132
Blue sheep	Indirect sighting	Dropping/Scats	27.349061	89.184107	4191

Blue sheep	Indirect sighting	Dropping/Scats	27.348558	89.176854	4143
Blue sheep	Indirect sighting	Dropping/Scats	27.345019	89.168626	4132
Blue sheep	Indirect sighting	Dropping/Scats	27.338883	89.160242	4305
Blue sheep	Indirect sighting	Dropping/Scats	27.339284	89.153129	4179
Blue sheep	Indirect sighting	Dropping/Scats	27.335765	89.158950	4337
Blue sheep	Indirect sighting	Dropping/Scats	27.331565	89.152838	4417
Blue sheep	Indirect sighting	Dropping/Scats	27.330641	89.151098	4373
Blue sheep	Indirect sighting	Dropping/Scats	27.330427	89.144630	4258
Blue sheep	Indirect sighting	Dropping/Scats	27.331316	89.139036	4176
Blue sheep	Indirect sighting	Dropping/Scats	27.334756	89.140997	4282
Blue sheep	Indirect sighting	Dropping/Scats	27.332646	89.140050	4238
Himalayan marmot	Direct Sighting		27.331683	89.138923	4174
Himalayan marmot	Indirect sighting	Track/Pugmark	27.332079	89.139089	4176
Blue sheep	Indirect sighting	Dropping/Scats	27.333661	89.139799	4241
Snow leopard	Indirect sighting	Dropping/Scats	27.336920	89.147966	4224
Red fox	Indirect sighting	Dropping/Scats	27.341452	89.163341	4226
Red fox	Indirect sighting	Dropping/Scats	27.346590	89.169501	4050
Blue sheep	Indirect sighting	Dropping/Scats	27.349473	89.175733	4122
Snow leopard	Indirect sighting	Dropping/Scats	27.352222	89.184724	4114
Himalayan marmot	Indirect sighting	Track/Pugmark	27.364243	89.180698	4105
Himalayan marmot	Indirect sighting	Dropping/Scats	27.379382	89.193181	4148
Blue sheep	Indirect sighting	Dropping/Scats	27.375491	89.209250	4151
Himalayan marmot	Indirect sighting	Dropping/Scats	27.368233	89.224001	4120
Himalayan marmot	Direct Sighting		27.372462	89.230495	4029
Yellow-throated Marten	Direct Sighting		27.375226	89.244440	3847
Pika	Direct Sighting		27.379733	89.242819	3687

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